July 4, 1911.

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POWER

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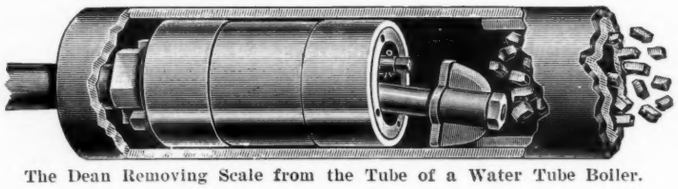
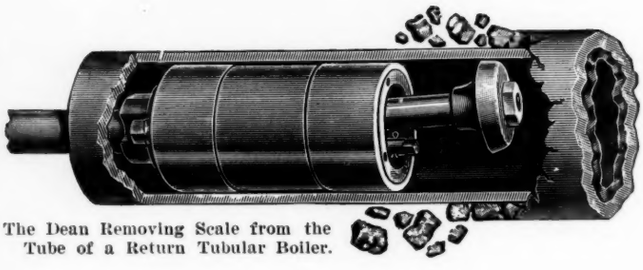
See if the trouble does not come from Scale!



The Dean Removing Scale from the Tube of a Water Tube Boiler.

Dean Boiler Tube Cleaner



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Let us send you one on trial. It won't cost you anything to try, and you will know for sure then.

Many a ton of scale have we seen removed from boilers that everyone about the plant said were clean.

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Want our Booklet "SCALE REMOVAL MADE EASY" first?

THE WM. B. PIERCE COMPANY

Chicago Office: 801 Steinway Bldg. **Jewett Building, Buffalo, N. Y.**

POWER

Vol. 34 NEW YORK, JULY 4, 1911 No. 1

HERE is foolish question No. 6,678,459: When is a man beaten?

Only when he thinks and admits that he is.

Mostly, success is built on failure. By this we mean that often success is attained only by the aid of experience gained through unsuccessful efforts. Point out the man who has never met with failure and we will point out a man who has never accomplished anything worth while.

Perhaps the saddest thing in all the world is to hear a grown man in the full possession of his faculties whimper that he "can't" do this or accomplish that. A man who is in such a mental panic that he refuses to make an effort to accomplish what he desires is almost without hope.

* * *

Some dogs are gun-shy. In certain cases this terror of firearms is inborn; in others it is due to a fright or perhaps an injury the dog has received during puppyhood.

Whatever the cause, the dog can never be broken of his gun-shyness.

There is a similarity between gun-shy dogs and opportunity-shy men—men who will not tackle an opportunity through fear of not being able to make good. Some men are born with a "yellow streak" in their makeup. Others, after meeting with two or three reverses, become a bit frightened and lose their nerve.

Here the similarity stops, however, for while the dog cannot be cured of his fright, the man can. The dog's power to reason is exceedingly limited: it is his instincts which influence his actions to the largest extent. In man the opposite is true: reason exerts the greatest influence and instinct plays but an extremely minor part. Hence, by self-education or otherwise, man may overcome his timidity.

Rightly constituted to begin with, or else rightly educated and trained if he has quitter instincts, a man who meets with a rebuff is only spurred to redoubled effort. Equipped with the experience gained during his former failure, the likelihood of his meeting with success is just so much greater. Thus it has been truly said that success often comes from the wisdom acquired during a multiplicity of failures and defeat is often but the forerunner of success.

When an honorable effort results in defeat it is a misfortune only when it gives rise to fear and prevents thereby further ventures.

When a failure acts as an incentive to increased effort it is often a blessing in disguise, bringing ability to attain greater success than otherwise could be hoped for.

Let's not worry, then, about the mistakes we have made; tomorrow will bring as good a chance as ever you let slip or slipped up on. And it's yours to tackle.

Electrification of Hoosac Tunnel

By Warren O. Rogers

For 35 years all trains were drawn through the Hoosac tunnel by coal-burning locomotives, but for the last few years oil-burning locomotives have been used for freight. The oil burners will soon be dispensed with and electric locomotives will draw both passenger and freight trains through the tunnel. An uptodate turbine plant will supply the electrical energy.

In 1840 plans were made for tunneling the Hoosac mountain, but after several experimental failures the task was abandoned for ten years. In 1851 the work was again resumed. From the summit of the mountain a shaft 15x27 feet in dimensions was sunk to a depth of 1028 feet, and a similar shaft was made upon the western slope of the mountain. With these shafts work went on at several different places as well as at both ends of the tunnel and engaged different forces of men. This preliminary work occupied four years of continuous labor and necessitated the expenditure of half a million dollars.

Twenty-five years after the work had been begun the bore was completed. On February 9, 1875, the first train of cars passed through the tunnel, although it was still far from completion. To prevent disaster from falling rocks the tunnel was securely arched, 20,000,000 bricks being required for this work. Fig. 1 shows a view of the west portal as it is today.

In the autumn of 1876 the tunnel was pronounced safe for travel and regular trains began to pass through it. This tunnel, which is 7¾ miles long, 26 feet wide and 26 feet high, is double tracked. In the beginning it was estimated that the total cost of construction would not exceed $2,000,000, but the actual cost was $20,241,842.31 and 195 lives were lost during the progress of the work.

The profile of the tunnel is made up of about 2.25 miles of 0.5 per cent. upgrade, a quarter of a mile of level track and about 2.25 miles of 0.57 per cent. downgrade. The west approach has an upgrade of 0.8 per cent. and the east approach an upgrade of 0.5 per cent. The steam locomotives will be hauled through the tunnel with the trains, but will do no work.

The passenger-train schedule is nine minutes, and the freight-train schedule

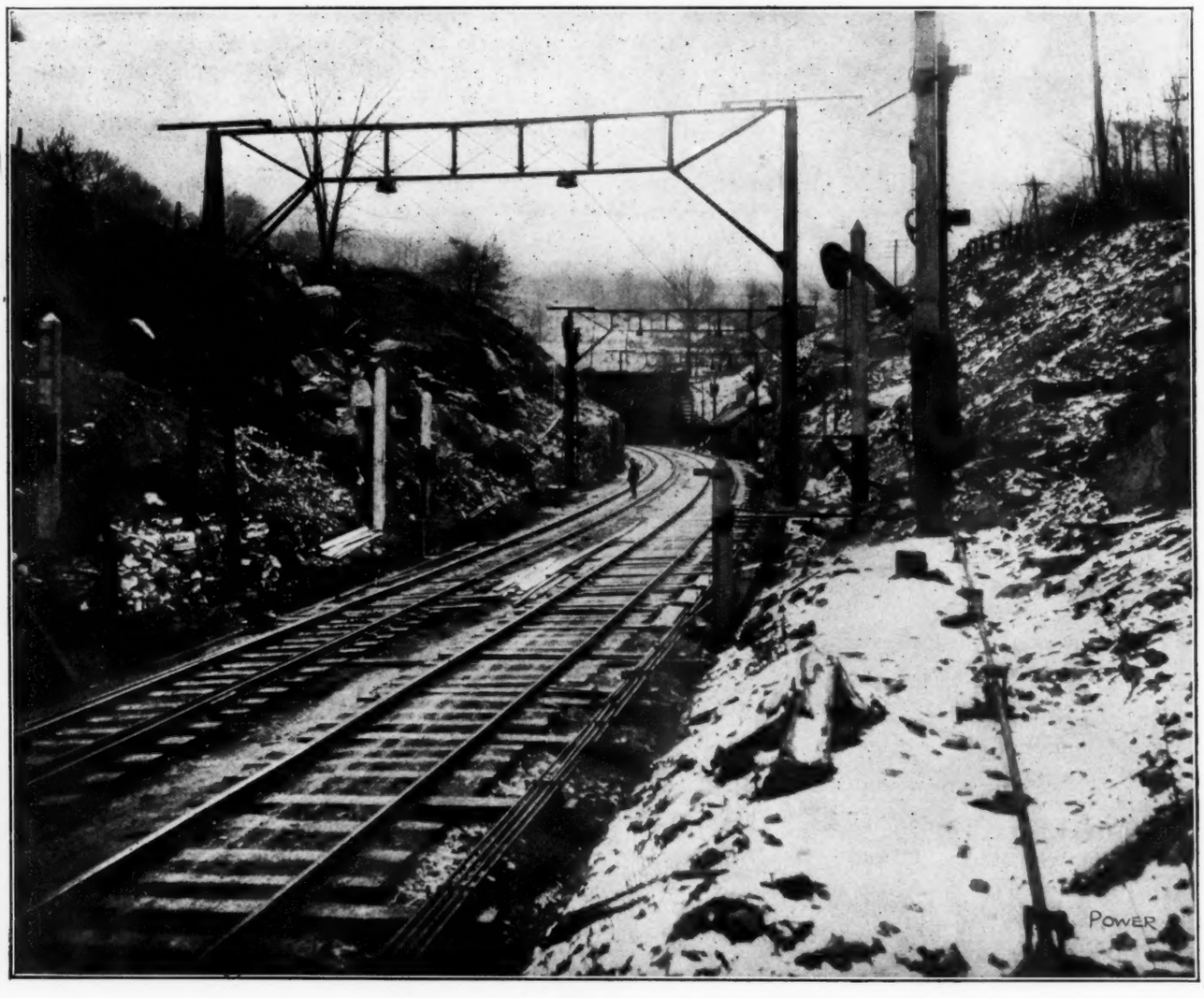


FIG. 1. VIEW OF THE WEST PORTAL OF THE HOOSAC TUNNEL

is 16 minutes in running through the tunnel.

For 12 months ending March 31, 1911, 522,526 freight cars and 35,600 passenger cars were moved through the tunnel by 44,542 engines. If these freight cars were coupled together they would extend from Portland, Me., to Los Angeles, Cal., and the passenger cars and engines would reach from Boston to Chicago, Ill. If the engines and the passenger and freight cars were coupled together it would take 17 days 2 hours for the train to pass through the tunnel at the rate of 12 miles an hour.

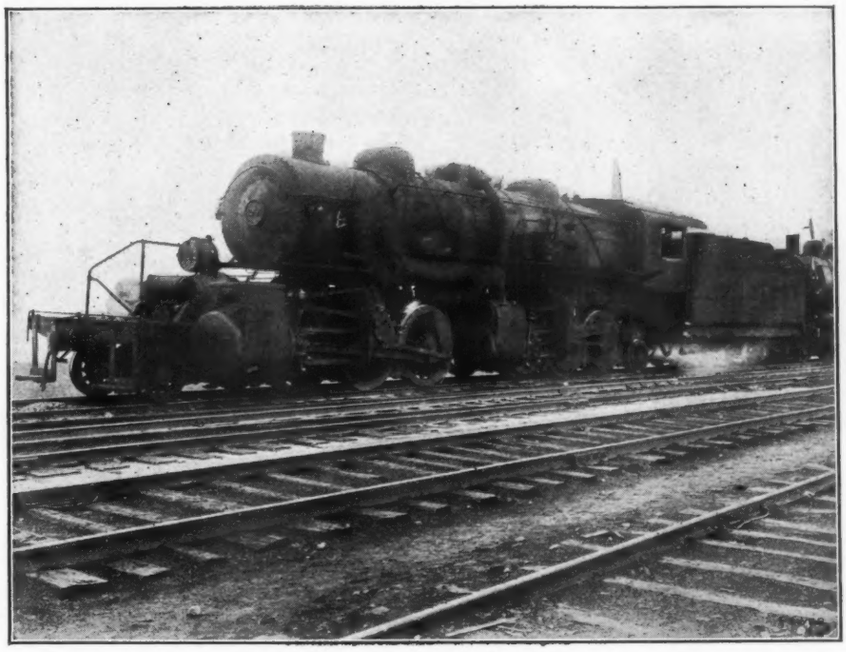


FIG. 2. ONE OF THE OIL-BURNING LOCOMOTIVES FOR FREIGHT SERVICE

At the present writing, all freight trains are drawn through the tunnel by oil-burning locomotives, one of which is shown in Fig. 2. It is of the Mallet articulated type and is compounded on both sides. This method of handling the trains gets rid of considerable smoke, but the average time (13 minutes) it takes a train to pass through is a decided objection to this arrangement.

A fan located at the central shaft draws the smoke out of the tunnel and when reversed forces the fresh air into the tunnel. Although this fan helps to free the tunnel from the obnoxious gases to some extent, they are at times most annoying to passengers and greatly delay the passage of trains.

To facilitate the handling of trains entering the tunnel, the Boston & Maine Railway Company has electrified the tunnel and line from North Adams, Mass., to a point several hundred feet beyond the east portal, a total distance of about seven miles. Fig. 3 shows the overhead-line construction in the North Adams yard, and Fig. 4 the method employed in securing the wires to the roof of the tunnel. The tunnel work required one thousand 2½-inch holes, 18 inches deep, drilled into the roof for hangers, and fifteen hundred 1¾-inch holes, 6 inches deep, for telephone- and signal-cable supports along the side walls. The holes are drilled and the hangers are located every 100 feet. Four roof holes and from 2 to 16 side-wall holes are also placed at the 100-foot point.

ELECTRIC LOCOMOTIVES

The five locomotives, built by the Westinghouse Electric and Manufacturing Company and the Baldwin Locomotive Works, for this work represent the latest and most powerful type of electric locomotive for use with alternating current. Two of them are shown in Fig. 5. The current at 11,000 volts, 25 cycles, is collected from an overhead wire and passes through a transformer in the locomotive. From this transformer various taps are led out so that any required voltage may be delivered to the motors.

Each locomotive is equipped with four 320-horsepower, 300-volt, single-phase motors which are bolted directly to the frames. They are connected to the driving wheels by flexible gears and a spring drive and operated by the multiple-unit electro-pneumatic control, making it possible to operate one or any number of locomotives together from one master controller; or, any motor can be cut out by opening its individual switch.

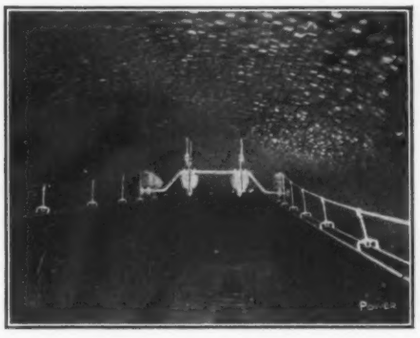


FIG. 4. SHOWING LINE CONSTRUCTION IN THE TUNNEL

Three of these locomotives are intended for freight service and are geared for a maximum speed of 30 miles per hour. These locomotives are designed to haul a train of 2000 tons through the tunnel without difficulty. The other two locomotives are for passenger service and have a maximum speed of 50 miles per hour.

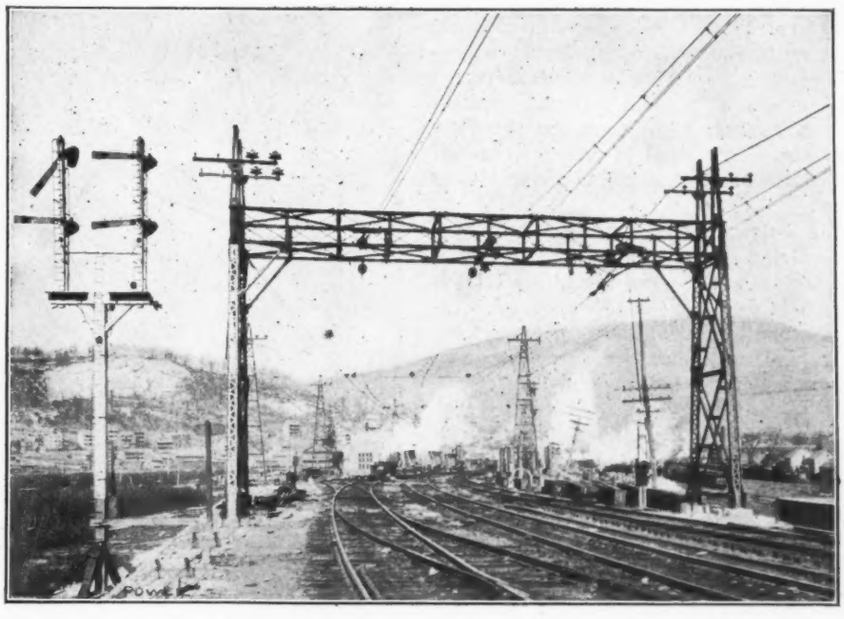


FIG. 3. OVERHEAD LINE CONSTRUCTION IN THE NORTH ADAMS YARD

Although they weigh approximately 250,000 pounds each, these locomotives, owing to their comparatively high center of gravity, their mode of suspension and

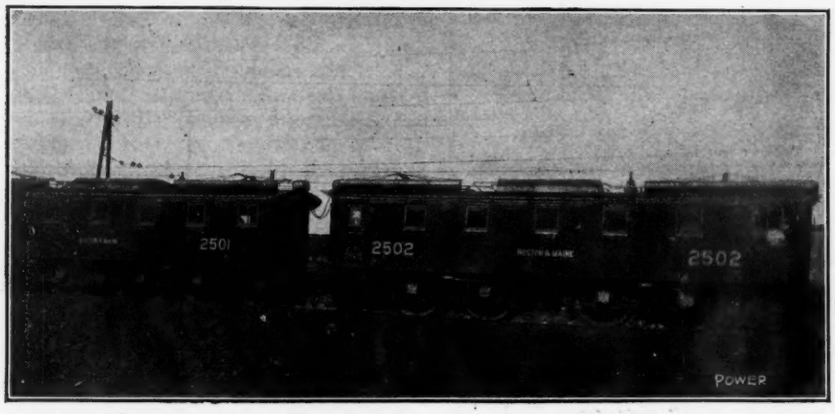


FIG. 5. TWO OF THE FIVE ELECTRIC LOCOMOTIVES

articulated trucks, ride very smoothly and do not exert excessive strains on the track.

The power plant that will generate the electrical energy for these electric locomotives is located at Zylonite, Mass., and the transmission lines run to switching stations located at both ends of the tunnel. The plan of the power house is 100x200 feet. The basement floor is on a level with the ground; the generating and boiler rooms are one story above, and a switch room is located at one end of the building.

BOILER ROOM

The boiler room (a partial view of which is shown in Fig. 6) is designed for ten 500-horsepower Bigelow water-tube boilers, four of which are in place at present, equipped with Taylor underfeed stokers. The stokers are driven by means of a chain belt and sprocket from a shaft hung from the basement ceiling. This shaft is driven by a belt from the shaft of a turbine-driven blower set.

A balanced-draft system is used for supplying air to the furnaces. In the basement are the two forced-draft fans; each is driven by a 150-horsepower direct-coupled Terry steam turbine, and delivers air to a sheet-steel air duct which runs under the boilers in the basement. From the top of this air duct there are four branch outlets. Each is made with a Y-shaped opening, each branch supplying air to a separate ashpit. The opposite outlets are blanked, having been arranged to take care of additional boilers when installed. Each boiler is equipped with a Foster superheater which superheats the steam 75 degrees.

In a room above the boilers and at one end of the building are two 12-foot induced-draft fans (Fig. 7), each driven by a Fleming fan engine.

The hot gases pass through a smoke flue to the Sturtevant economizer and are drawn through it to the stack by the 12-foot fan, manufactured by the Massachusetts Fan Company. In case the economizer is cut out of service the gases are bypassed directly to the fan and the 12-foot stack. Provision has been made for the installation of two more induced-draft fans of the same size as those now installed.

The forced-draft fan creates a draft of 3 inches, the induced-draft fans from 3/10 to 5/10 inch.

HANDLING COAL AND ASHES

Coal is delivered to the plant in hopper cars and is dumped into a hopper from the car and passes through the bottom into the buckets of a Bergen Point Iron Works bucket conveyer 75 feet long and capable of handling 40 tons of coal per hour. The conveyer travels in a runway supported on trestle work; the runway is covered with a galvanized corrugated-iron casing, as shown in Fig. 8.

The coal is discharged into a 75-ton storage bin, but before reaching the storage bin the coal passes through a set of coal-crushing rolls. From this storage bin the coal is delivered to the stokers by a trolley-traveling coal car capable of handling five tons per trip. The car is fitted with a spout and the coal is delivered directly into the hopper of the stokers. There are two of these cars, the duplicate car being for service when another row of boilers shall have been installed. The tracks upon which the cars run are carried by the iron framework supporting the boilers and building proper. One of the conveying cars is shown in Fig. 9. Each car is equipped with scales for weighing the coal.

All ash from the furnace drops into an ashpit hopper, the sides of which slant

FIG. 6. PARTIAL VIEW OF THE BOILER ROOM

FIG. 7. INDUCED FAN IN FAN ROOM ABOVE THE BOILERS

toward a common center. Suitable gates are arranged at the bottom through which the ash falls into an ash car which runs on an industrial track to the outside of the plant. This feature is shown in Fig. 10.

FEED WATER

Feed water will be obtained from ten artesian wells, each 100 feet deep, six of which are now in operation. The wells are expected to deliver 10,000 gallons of water per minute into a reservoir located under the turbines. It is pumped by a 14 and 12 by 12-inch Platt Iron Works service pump through a Hoppes open feed-water heater and Willcox water weigher to an iron hotwell tank located in the basement of the boiler room. The water is pumped from the hotwell to the boilers after passing through a Sturtevant economizer by either of two 12 and 7½ by 15-inch Worthington pot-valve, outside-packed, duplex, boiler-feed pumps. These pumps are also connected to the circulating-water intake from the cooling pond so that pond water can be used for boiler feeding should it become necessary. All duplex pumps in the plant are equipped with automatic governors.

PIPING

There is but one feed-water line and one main steam line. All steam piping drops down through the floor to the basement where possible. The exhaust steam from all of the auxiliaries passes to the heater. Fig. 9 shows a partial view of the piping over the boilers. A plan and an elevation view of the plant are shown in Figs. 11 and 12 respectively.

CONDENSERS AND COOLING POND

Each turbine exhausts into a Westinghouse Leblanc condenser, one of which is shown in Fig. 13. The circulating pump is driven by a Westinghouse steam turbine at 1000 revolutions per minute. Water is taken from a cooling pond at one side of the power plant, and thence from a concrete intake through a raceway made of planking which runs to the far end of the pond. This enables the pump to draw from the coolest water. The water from the condenser runs into a reservoir and is pumped through 110 Schutte

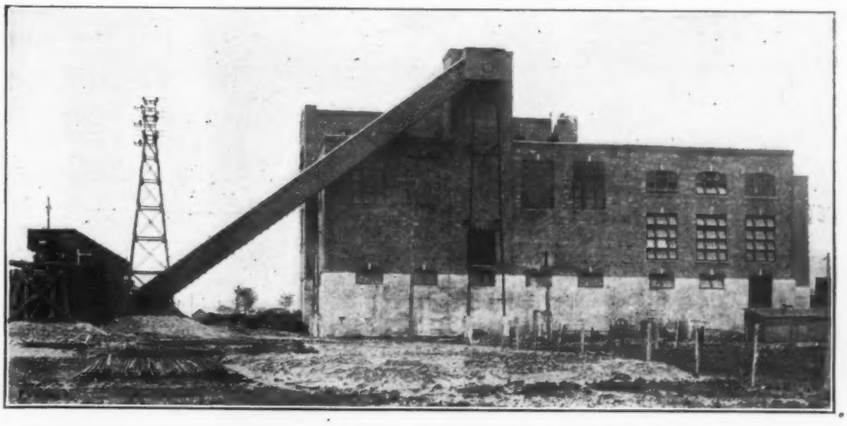


FIG. 8. EXTERIOR OF THE PLANT, SHOWING COAL CONVEYER

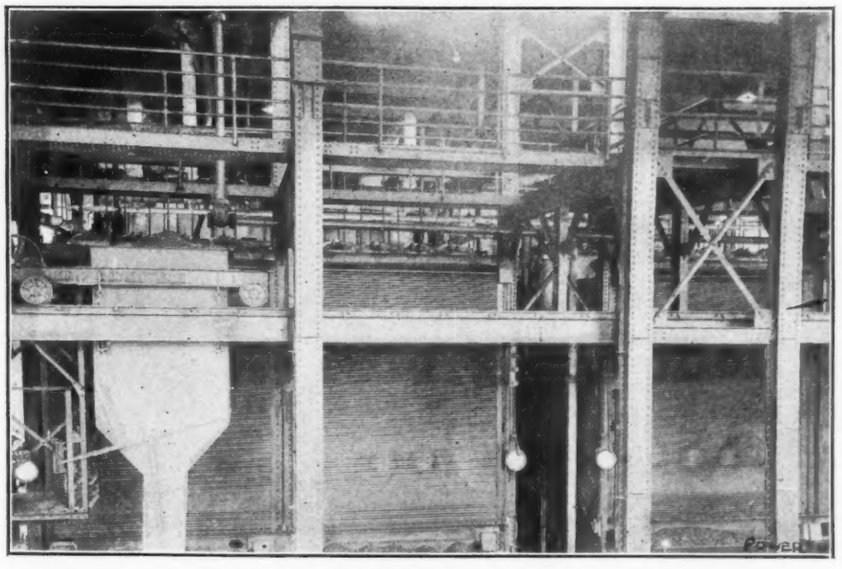


FIG. 9. VIEW OF THE PIPING OVER THE BOILERS

& Koerting spray nozzles, 80 of which are 2½ inches and 30 are 3 inches in size. The piping supporting these nozzles is 10 inches in diameter at the start and is gradually reduced to 6 inches in diameter at the extreme end. Fig. 14 shows one of the spray pipes with the nozzles in op-

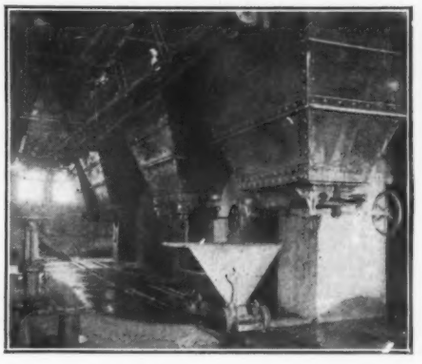


FIG. 10. ASH CAR UNDER ASH HOPPER

eration. The water is pumped from the condenser hotwell to the spray nozzles by means of a vertical 100-horsepower induction motor direct coupled to a 16-inch Worthington centrifugal pump. There is also a 12-inch pump of the same make that is driven by a 9x10-inch Blake vertical engine. This unit is not of sufficient capacity to handle all of the condensed water and is held as a reserve unit whereby the excess water can be discharged direct to the cooling pond through gates provided for that purpose.

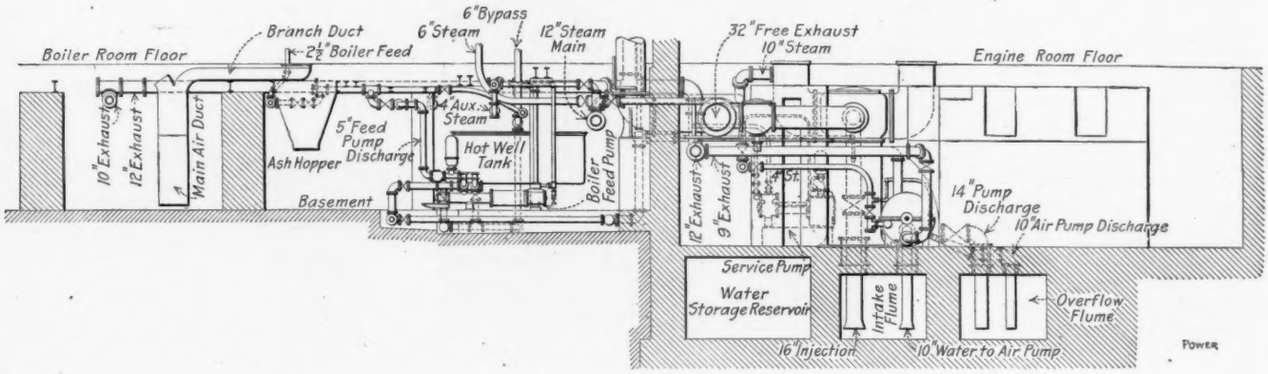


FIG. 12. SECTIONAL ELEVATION OF BASEMENT, SHOWING PUMPS AND PIPING

TURBINES

There are at present two 3750-kilowatt Westinghouse double-flow steam turbines in place, delivering electrical energy to the lines at a pressure of 11,000 volts. These are single-phase, 25-cycle generators and run at a speed of 1500 revolutions per minute. The generators are cooled by air taken in through the side wall of the turbine-room basement and passes to the generators through a galvanized air duct. Fig. 17 shows a portion of the turbine room.

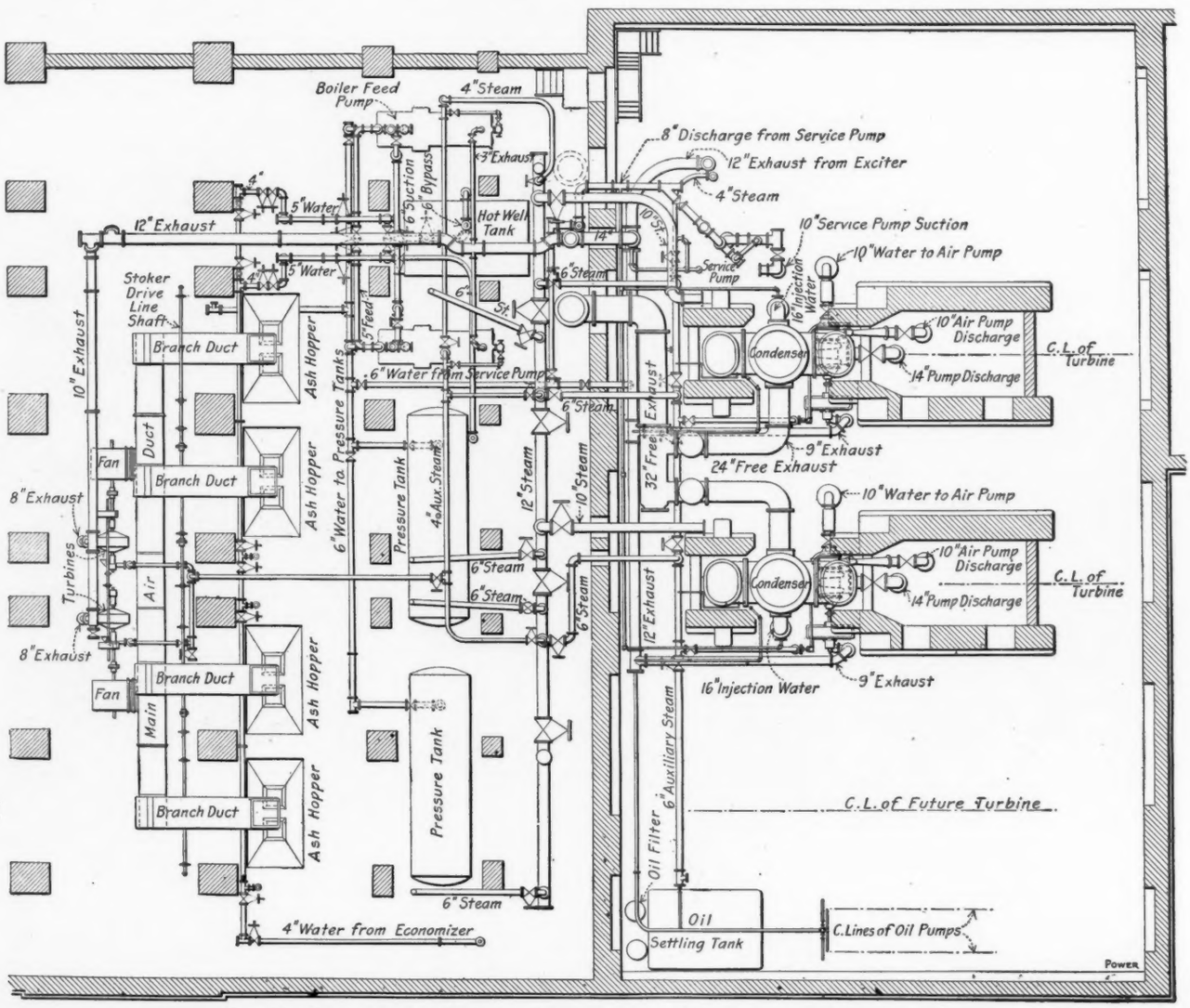


FIG. 11. PLAN OF THE GENERAL LAYOUT OF THE MACHINERY, BOILERS AND PIPING

Owing to the incomplete condition of the turbine room at this writing, a photograph showing it in its entirety could not be obtained.

There are two exciter units: one consists of a 100-kilowatt, direct-current generator and is driven by a 150-horsepower three-phase induction motor. The other set consists of a 100-kilowatt direct-current generator direct coupled to a Westinghouse turbine.

There is also a small motor-driven set that is used for charging the storage battery, but it can also be used for a short period to furnish exciter current for the main generators, the motor being driven from the storage batteries. This set consists of a 12-horsepower three-phase induction motor and a 7½-kilowatt direct-current generator, both mounted on the same shaft.

A motor-driven air compressor, capable of displacing 50 cubic feet of air per minute, at 183 revolutions per minute, is driven by a 15-horsepower three-phase induction motor. The air is used for cleaning the generator, etc.

All motors are of the three-phase, 25-cycle, 440-volt type and the electrical equipment throughout is of the Westinghouse make. These auxiliary units are shown in Fig. 15.

The bearings of the turbines are cooled by water circulating around them, the water being pumped by the service pump into a tank located in the induced-fan room over the boiler; it is shown in Fig. 7.

Here also is the oil tank containing the clean oil used in the turbine bearings. After leaving the bearings the oil flows by gravity to an oil filter in the basement and, after passing through the filter, is pumped by means of the Worthington 6 and 7½ by 6-inch pumps to the oil tank in the fan room, whence it returns to the bearings by gravity

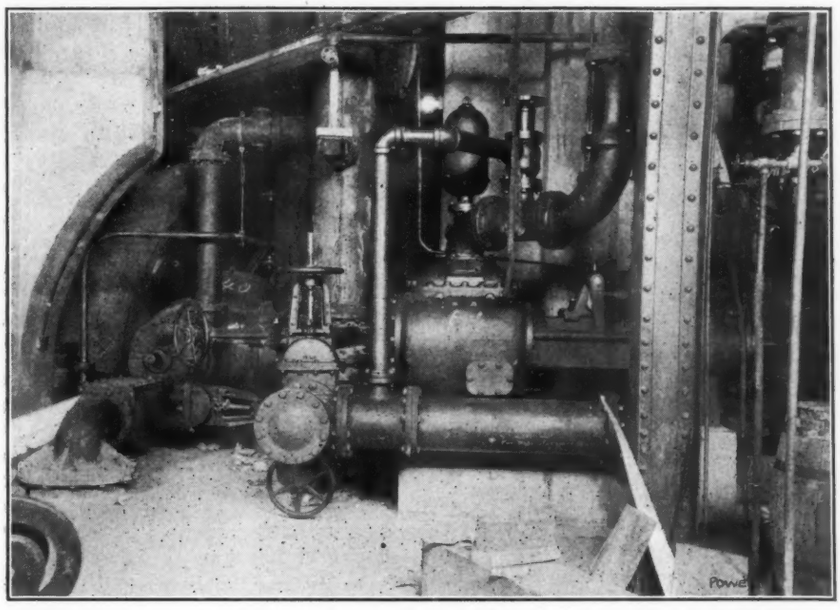


FIG. 13. LEBLANC CONDENSER CONNECTEDTO DOUBLE-FLOW TURBINE

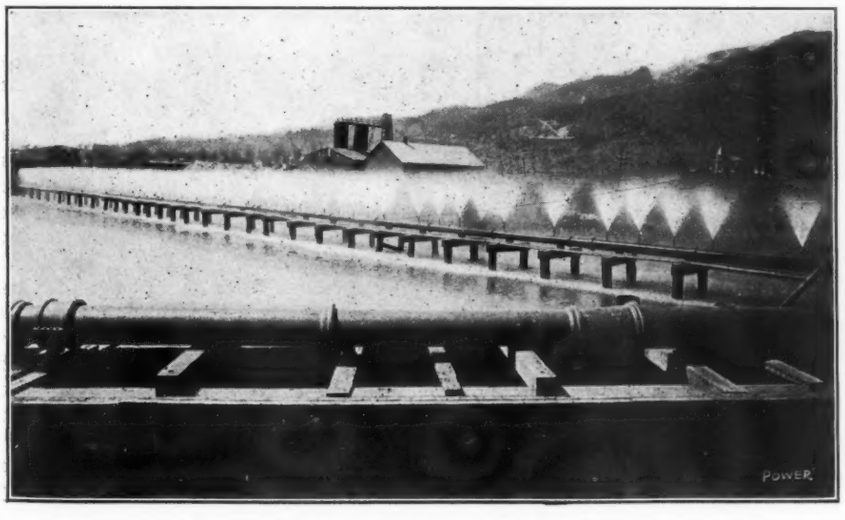


FIG. 14. ONE OF THE SPRAY PIPES IN OPERATION

ELECTRICAL TRANSMISSION

The necessary apparatus for handling the electric-energy generator is located at one end of the building in an alcove off the end of the generator room. The transformer for the station is built back of the switchboard in the second story.

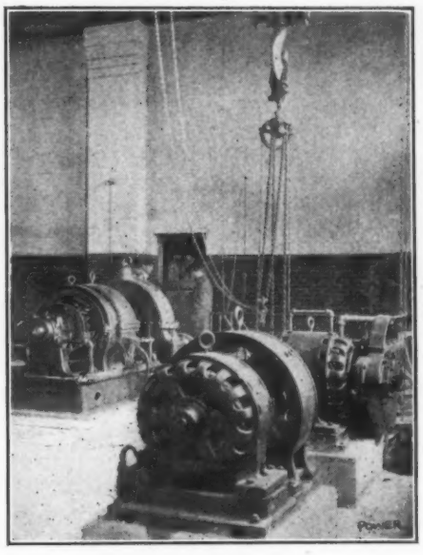


FIG. 15. EXCITER UNITS AND AIR COMPRESSOR

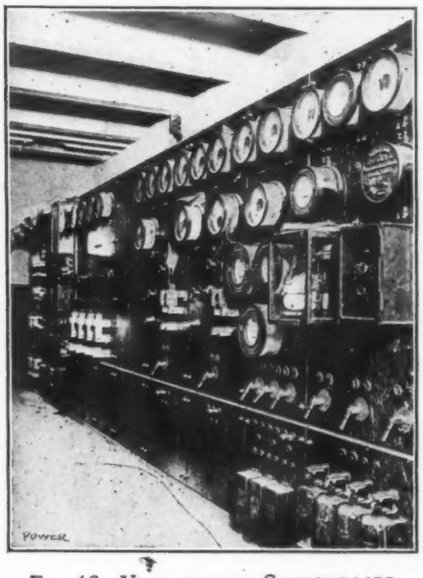


FIG. 16. VIEW OF THE SWITCHBOARD

Oil switches are also placed back of the switchboard, which is shown in Fig. 16. The transmission lines run from the station on dead-end steel towers of the flexible type to a switch house at the entrance of the west portal of the tower, 2½ miles distant.

Burning Gas under Boilers

By G. A. Glick

Gas as a fuel possesses certain advantages, some of which are as follows:

Gas can be regulated and burned under a boiler in a very uniform manner.

It can be fired so that the boiler will carry a heavy overload.

As fuel in a boiler room it means a considerable saving in labor, as fewer firemen are required and there are no ashes to be handled.

Gas has no detrimental effects upon the boiler; at least, none have been shown up to the present time.

High boiler efficiencies may be obtained with gas if fired correctly.

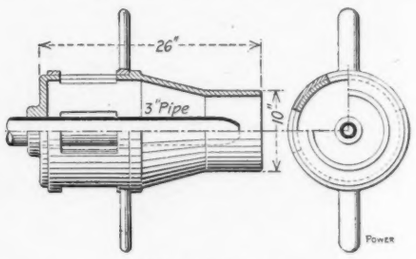
Artificial gas is usually too expensive to burn beneath a boiler, and for a long time natural gas has had no competitor in this class of work. Of late, however, many of the steel companies of this country have erected byproduct coke ovens near their mills in order to obtain coke for the different metallurgical operations, and in this process a large amount of gas is given off as a byproduct. This is rich in hydrogen, of which it contains about 50 per cent., and also contains about 25 per cent. of methane in addition to some carbon monoxide and ethylene. The gas has a heating value of about 540 B.t.u. per cubic foot, and about 20 cubic feet is equivalent to a pound of Illinois coal.

This gas is being burned successfully under a 400-horsepower Stirling boiler with the standard combustion chamber, and under a 300-horsepower Rust boiler having the dutch-oven type of combustion chamber. A burner of the type shown in the illustration is used and is similar to the well known Bunsen burner. The main gas header runs along the front of the boilers and has drop legs to each of the burners, which are placed in the doors of the furnace, one burner to each door. These drop legs are flanged about seven feet from the floor so that the burner can be removed quickly in case the gas supply should fail, and it is desired to fire the boilers with coal. The whole operation of removing the gas burners and building a coal fire can be accomplished in 30 minutes.

As seen from the illustration, the burner consists of three principal parts: the inner pipe carrying the gas, the large outer pipe carrying the air, and the sliding sleeve over this air pipe for adjusting the air supply. The burner is of cast iron and is machined over the part upon which the sleeve slides. The ashpit doors are kept closed and all other openings are sealed, so that practically all the air supply enters through the burner. This makes the control of the air supply very easy, and uniform conditions are obtained.

At first the grates were covered with a course of brick with an opening 4 inches wide across the front of the combustion chamber. Checkerwork of firebrick was also built up in front of the bridgewall. It was found, however, after changing to coal that the results were just as good when the grates were sealed with ashes and cinders, and the checkerwork and other brick in the combustion chamber were dispensed with.

The general operation of the boiler is as follows: The gas is delivered to the burner at a pressure of about 3 inches of water and the amount of gas is regulated by a plug cock. The air supply is regulated at the burner and may be made to burn the gas with a blue flame. It was thought at first that this flame might be more efficient than the yellow flame, but actual tests showed practically no difference, the boiler efficiency in both cases being over 70 per cent. This lack of any difference due to the flame is an important point and seems to be due to the fact that coke-oven gas, being composed principally of hydrogen and quick-burning hydrocarbons, is largely burned before reaching the cool tubes where the unburnt carbon might deposit. At first after removing the checkerwork in the boiler it was feared that the tubes might become blistered, but no more trouble has been experienced with gas than with coal, especially in the case of the Stirling boiler. This boiler may be forced to 50 per cent. above its rating with no danger of blistered tubes, while the Rust boiler, owing to the vertical construction of the tubes, is only carried to 15 or 20 per cent. above its rating.



Gas Burner

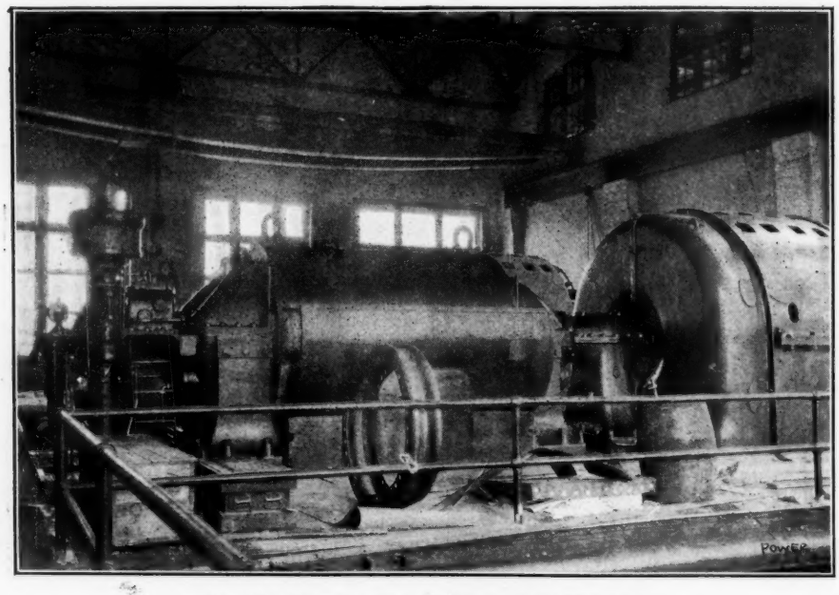


Fig. 17. One of the Double-flow Turbines

The Supply of Coal

The *Black Diamond* recently credited the Government with the following interesting information, as to the estimated quantities of coal remaining in the ground:

The Government has not considered anything which runs below 3000 feet. Upon that basis, taking the area known to contain coal and figuring all of the seams known to exist and figuring 1200 tons as recoverable under present methods from each foot thickness of coal from one acre, the Government comes to the conclusion that the recoverable amount of coal is 9,000,000,000,000 tons, which means that 9,000,000,000,000 tons is 60 per cent. or thereabouts of the coal actually in the coal measures and that this amount could be increased if our methods of recovery could be improved.

In contrast, the Government put out a statement of the amount of coal which has been extracted from the ground so far in the history of this country. The statement is made that not to exceed 11,000,000,000 have been taken out. If we have 9,000,000,000,000 tons remaining and if it has taken us 75 years to take out 11,000,000,000, it would seem that we have enough coal to last for a considerable period.

However, the point is not mentioned that most of this coal is at perhaps an average of two thousand miles away from the present centers of population. No considerable part of this coal is given as lying east of the Mississippi river.

Some Notes on Purchasing Power

By Henry D. Jackson *

Contracts between the central station and power users are as a rule complicated and misleading, and are usually all in favor of the central station. The contract should be worded so as to be equally understood by both parties, and the consumer should insist on equal protection.

*Consulting engineer, Boston, Mass.

The average power purchaser is very much at sea when examining the contracts submitted by many of the power companies, these contracts being so worded as to be beyond the understanding of the average man, and some of them beyond the understanding even of the technically trained man. This is largely due to attempting to get a sliding scale of prices for various conditions of power service all into one form of contract. In some contracts the prices vary widely, depending upon the amount of power consumed during the month; and in addition to these, there are discounts which also modify the final price, these discounts applying in such a way as to make it almost impossible for the average consumer to figure out what his power bills actually are—he either having to hire an expert for the express purpose of checking his power bills, or to go on the assumption that the bills as rendered are correct and pay them without question. This latter method is hardly to be commended, as few of us would be willing to pay our bills blindly, with the idea that they are always correct; we prefer to check them up and know what we are paying for. In some cases even after very strenuous effort to explain on the part of the representatives of the power company, we have found that the consumer is absolutely at sea as to how the bills are made out.

Contracts of this character should be discouraged, and the consumer should take the ground that a contract should be so plain and distinct as to be readily understood by anyone of reasonable intelligence who will carefully read it.

There are other contracts based upon a maximum demand, a fixed charge per horsepower of connected load, and a sliding scale by means of which the power bill may be calculated by one who understands the language in which the contract is written. This, however, is by no means always the case, for kilowatts, kilowatt-hours, amperes, ampere-hours and horsepower are so frequently mixed up as to make it difficult for the uninitiated to translate what the contract actually refers to.

The maximum demand as frequently expressed, is one which the average consumer has hard work to understand, and also the length of time over which the maximum demand extends or upon which time the maximum demand rate is charged also is a matter of extreme difficulty. Some contracts allow the maximum demand to be that power which will exist for a period of half an hour; others fifteen minutes, and others take the extreme position of two minutes. This latter figure in many cases might mean that the purchaser is paying for a vastly greater amount of power than is justified, owing to the starting conditions and method of starting employed on the premises. The limiting period or the shortest space of time which should be allowed in any contract upon which the maximum demand is figured, should be 10 minutes, and preferably half an hour, although under special conditions a shorter time might be allowed if the consumer is thoroughly well up on what the term means. The maximum demand should mean, and is meant to mean, the maximum peak load which may occur, which will last over the period stated under the head of maximum demand. The time limit should be sufficiently long so that this will not include a temporary short circuit, a temporary overload, or the possibility of the starting load all coming at once and lasting over this period. Care should be taken in the operation of the plant that the motors are started so that the starting load does not all come at once.

The fixed price, or as it is frequently known, the readiness to serve charge, based on the horsepower of motors installed, is frequently a hardship and often a charge which is not warranted by the conditions of the plant; while at the same time it is a fair charge in many other plants. Take a plant, for instance, which may have a very large connected load, a small portion of which is in operation at any one time, and the readiness to serve charge would frequently amount to more than the total power bill of the plant per month; or a plant where during certain months of the year business is rushing, the readiness to serve charge may be a fair one during these periods, but during slack periods the readiness to serve charge would be excessive and cause an actual hardship upon the plant. The power companies take the ground that this readiness to serve charge is only a fair interest on the apparatus required to furnish this power. At the price often charged for this service, it would not only represent interest, but also maintenance, depreciation, and a good deal of the operating charges on the machinery.

The minimum charge basis is also the subject of a good deal of controversy, and frequently the cause of hard feelings, as the purchaser cannot understand why he should pay for power when he does not use it, and cannot understand the basis upon which this charge is made. This is frequently made a part of the fixed price or the readiness to serve charge, but at times it is also made as a separate item.

As a rule the power contracts are written by and for the power company in such a way as to give everything to the power company and leave as little as possible to the consumer. This is not unnatural, because the intention is to protect the power company in every possible way; and it is up to the consumer to see that, from his side, equal protection is afforded him. This, however, the consumer as a rule is unable to do, because he does not know enough of the conditions to thoroughly understand what the contract means. It may be that any one signing a contract that he does not thoroughly understand, is foolish; but a large number of the power consumers take it for granted that the contract is a fair one and also are frequently assured by the sales agent that the contract is a fair one, and sign accordingly.

It is not infrequent to find that the sliding scale is not well understood; and upon the purchaser questioning the sales agent, he is assured that this method of charging is only a fair and just one which is based upon the fact that the small user naturally would expect to pay a higher amount for power than the larger one, and attention is frequently called to the very low rate for the power which will be furnished, this being, of course, to apply to the power above a certain amount. This latter statement, however, is not strongly called to the attention of the purchaser. Attention is merely called to this very low rate, without any stress being laid on the fact that this applies only to the power purchased above a certain amount. When the bills are rendered, the purchaser frequently finds that they are very much higher than he anticipated, and upon complaint, he is referred to the power schedule. He finds that he has hardly reached during the entire month that consumption which will allow any considerable portion of his power to be based on the minimum charge, and he frequently feels that he has been misled, and frequently has been misled, by the statements of the central station agents.

A good many of the power contracts are so arranged that the power company has any number of chances of breaking the contract if the conditions of operation are not such as they desire, but very seldom found to give an equal opportunity to the purchaser. Some contracts recently issued are exceedingly unfair in this particular, giving the power company unlimited opportunities for failing to deliver power, for breaking the contract and otherwise making trouble; while leaving the purchaser absolutely powerless. One contract agrees in one portion to deliver continuous power, whereas in another portion of the contract it is expressly stipulated that during low water they may not deliver power if water is not available. They are also allowed to hold the purchaser to the contract even although they fail to deliver power for a continuous period of some months; whereas there is no provision made by means of which the purchaser can break the contract. There is inserted a provision which says that the party aggrieved may terminate the contract, but it would puzzle the judges of the Supreme Court of the United States to determine wherein under the contract the purchaser could be called the party aggrieved, whereas practically every clause allows the power company to appear to be the party aggrieved.

Another contract has the power schedule so arranged that it would puzzle a corporation lawyer to determine whether or not the bills were correct; and also gives the power company the right to charge for power on the basis of the meter readings and gives the consumer no provision to have these meters corrected or make claim for overcharge if meters are incorrect.

The purchaser of power should read carefully the contract submitted by the power company, and if any clauses are not definite and thoroughly understood, should submit the contract to an unprejudiced person thoroughly understanding the conditions, for him to decide whether or not the contract is a fair one, and if necessary to write in such additional clauses as will thoroughly protect the consumer.

After this has been done for a reasonable period of time, it may be that the central-station contracts will be brought to a more uniform basis, and one which will treat the consumer very nearly as favorably as the central station. At the present time contracts are all in favor of the central station, and the consumer signing them has little or no opportunity for getting back at the central station.

Contracts are, of course, a necessity, as it is only through some written agreement that any dodging of the responsibility or any misunderstandings can be prevented. This does not mean, however, that the contract should be so worded as to be misleading or indefinite. The prime requisite of a contract is to cover all contingencies completely, accurately and clearly, dealing absolutely impartially on all matters under consideration, so that each party to the contract be treated the same. In order to do this it is absolutely essential that the contract should be so worded that it will be equally well understood by both parties. Such is by no means true of the contracts of most power companies as now written.

Comparative Economy of Saturated and Superheated Steam

By Edward L. Jones

The following results were obtained from tests made in the engineering laboratory of Lehigh University by senior mechanical engineers to show the gain in economy by using superheated steam.

The engine used was of the vertical reversing marine type, $8\frac{2}{32}$x$5\frac{13}{16}$ inches, with a $1\frac{9}{16}$-inch rod, the clearance being about 13 per cent. These are rather unusual proportions, but a partial explanation is that the engine was originally tandem-compound, and the cylinder now used for the simple engine was the low-pressure cylinder of the compound.

For the superheated-steam tests, steam was run through a separately fired Ingersoll-Rand air reheater which was used for heating both air and steam. The engine exhausted into a surface condenser open to atmospheric pressure, and the condensation passed thence into a weighing tank. The power was absorbed by a prony brake on a 36-inch wheel with an arm 49½ inches (4⅛ feet) long, and the force was weighed on a 200-pound spring balance with a 100-pound weight suspended from the knife edges. The object of this arrangement was to make it possible to run the engine in either direction, as when running one way the driving force would lift up on the weight. It was found as an additional advantage, that the mass of the weight aided greatly in eliminating excessive vibration of the scale pointer.

Each run was divided into ten six-minute intervals, and speed counter and weight readings were taken at the beginning and end of each interval, while indicator diagrams, pressures, temperatures, brake readings, etc., were taken at the middle of each interval.

The tests show a marked gain in efficiency for the superheated steam, and the results of the two sets of runs agree fairly well with each other. The variation of the mechanical efficiency may be due to the different setting of the reversing lever.

Attention is called to the close agreement of the indicated and the actual steam consumption in both superheated-steam tests. In calculating indicated steam consumption the assumption was made that the steam was saturated at the points of measurement—shortly after cut-off on the expansion curve, and near the lower end of the compression curve—but the point to be noticed is that the indicated steam consumption under such assumption is almost the same (slightly greater) than the actual consumption as determined by weighing the condensed exhaust, thus showing the entire absence of cylinder condensation, and the gain in economy is no doubt due to that fact.

DATA AND RESULTS

	Saturated Steam	Superheated Steam	Saturated Steam	Superheated Steam
Run number	1	2	3	4
Date	Mar. 21	Mar. 21	Mar. 22	Mar. 22
Duration	1 hr.	1 hr.	1 hr.	1 hr.
Position of reverse lever	¼ N.	¼ N.	⅛ N.	⅛ N.
Revolutions per minute	176.5	179.7	174.8	179.3
M.E.P., head	19.7	20.7	25.8	28.4
M.E.P., crank	18.4	17.9	24.5	23.1
Scale of indicator spring	40	40	40	40
Indicated horsepower, hd	3.18	3.40	4.12	4.65
Indicated horsepower, ck	2.91	2.88	3.83	3.71
Indicated horsepower, total	6.09	6.28	7.95	8.36
Brake load, net (lb.)	42	42	52	52
Brake horsepower	5.82	5.93	7.13	7.32
Mechanical efficiency (%)	95.7	94.3	89.7	87.6
Steam used per I.H.P. hour	54.1	33.6	47.7	31.4
Steam used per B.H.P. hour	56.6	35.6	53.2	35.9
Steam pressure, gage	90.4	89.0	88.9	84.7
Corresponding steam temperature	331.5	330.5	330.4	327.4
Observed admission temperature	330.0	479.6	328.9	464.0
Number of degrees of superheat	.....	149.1	.....	136.6
Exhaust temperature	217.1	232.5	219.5	226.0
Total heat per pound of steam at upper pressure and temperature	1187.22	1265.04	1187.00	1258.00
Deduct for 2 per cent. of moisture	17.70	.....	17.70	.....
Deduct for water heat at free exhaust temperature	180	180	180	180
Heat used per lb. of steam	989.52	1085.04	989.30	1078.00
Work per lb. of steam (B.t.u.)	47.1	75.7	53.3	81.0
Absolute efficiency (%)	4.77	6.97	5.38	7.52
Indicated steam consumption per I.H.P. hour	41.0	36.5	35.2	32.3
Steam not accounted for by indicator, lb	13.1	negative	12.1	negative
Cylinder condensation (%)	24.2	.....	25.4	.....

Announcement was recently made in San Francisco that the Great Western Power Company will build at Big Meadows, Cal., a reservoir that will be the largest in the world, surpassing in capacity the Roosevelt dam and reservoir in Arizona, and the Assouan dam in Egypt.

Notes on the Size and Care of Belts

By W. R. Willard

The disadvantages of tight belts are considered and a method given for computing the size of belt required to transmit a given power at a given speed.

Since a large percentage of the power used in industrial plants is transmitted by belts, everyone who has charge of transmission equipment is, or ought to be, on the alert to reduce, if possible, loss of power, the number of new belts required and the time lost in repairing old ones to a minimum. A broken belt often will delay the work of from one to fifty men from ten minutes to an hour. Of course, if a new plant is being designed the transmission can be arranged to give the best possible results. But if a man has the conditions in an existing plant to cope with he must be content to eliminate the effects of poor design as best he can.

Tight Belts

Tight belts are very often the root of much trouble. A tight belt has a short

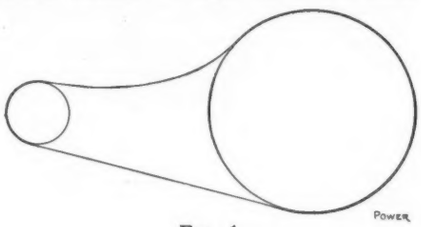


Fig. 1

life and produces excessive friction in the bearings, and if too tight, it may bend the shaft and injure the pulleys, to say nothing of the loss of power which it causes. There are various ways in which to overcome this difficulty. If the belt is a vertical one, or nearly so, the angle to the horizontal should be reduced to 45 degrees, if possible. Figs. 1 and 2 show very clearly the disadvantages of an upright belt as compared with a horizontal one; both have the same tension, but, while the one in Fig. 1 will transmit much power without slipping, the one in Fig. 2 will scarcely grip the lower pulley at all. Also, in order to transmit the same amount of power as the horizontal belt, the vertical one must be made very tight. This is especially true when the lower pulley is smaller than the upper. If they were reversed it would be somewhat better but still objectionable. If the power to be transmitted were small and the belt larger than would be required under ordinary conditions, the results would be fair. A guide pulley placed as shown in Fig. 3 would do much to help the belt to grip the lower pulley, and even two such pulleys, one on each side, would be more helpful.

If the tight belt is horizontal it will, in most cases, be found to be too small to carry the load and a larger one must be used. After a belt is stretched to its elastic limit it cannot be made any tighter. In fact, no belt should be stretched to a point closely approaching its elastic limit, but instead a good factor should be allowed. The following method will be found to give accurate results in finding the width of a belt:

Let

S = Speed of the belt in feet per minute;
H = Horsepower to be transmitted;
P = Difference in the pull on the tight and on the slack sides of the belt.

Then,

$$P = \frac{33{,}000 \times H}{S}$$

Assume a case where it is required to transmit 25 horsepower with the small pulley 4 feet in diameter, running at 300 revolutions per minute, and that the arc of contact of the belt on the small pulley is 160 degrees. Neglecting slip, the speed of the belt is the same as the speed of the circumference of the pulley. This would be

$4 \times 3.1416 \times 300 = 3770$ *feet per minute*

Substituting this in the formula

$$P = \frac{33{,}000 \times 25}{3770} = 218.8 \text{ pounds}$$

This is the difference in tension on the tight and on the slack sides of the belt. From the table it will be found that the ratio of these tensions is 2.311 if F be taken as 0.3. Assuming that ordinary single leather belting will pull with safety 80 pounds per inch of width, the latter will be

$$\frac{218.8 \times 2.311}{80} = 6\tfrac{5}{8} \text{ inches}$$

Angle of Contact, Degrees	Ratio of Tensions, $\frac{T_1}{T_2}$	
	$F = 0.3$	$F = 0.4$
20	1.110	1.150
40	1.233	1.322
60	1.369	1.520
80	1.520	1.784
100	1.688	2.010
120	1.874	2.311
140	2.081	2.658
160	2.311	3.056
180	2.566	3.514
200	2.850	4.040
220	3.164	4.646

F represents the coefficient of friction.
T_1 represents the tension on the tight side.
T_2 represents the tension on the slack side.

If the belt has laced joints the safe working tension may be taken from 250 to 350 pounds per square inch in section. To find the safe tension per inch of width of any belt it is necessary to multiply this by the thickness. The pulleys should always be made as large as possible, providing the speed of the belt does not exceed about 4000 feet per minute. A few belts have been run at as high as 6000 feet per minute, but this is uncommon.

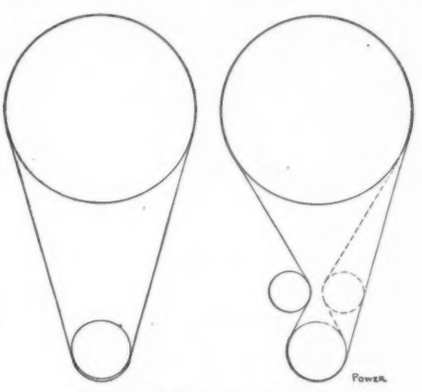
Sometimes one wishes to make use of an old belt and desires to know the size of pulley to use, in which case the following formula will give the correct diameter:

$$D = \frac{2000 \times H}{R \times A \times W}$$

where

D = Diameter of the small pulley in inches;
H = Horsepower to be transmitted;
R = Revolutions per minute;
W = Width of belt;
A = Ratio of the arc covered by the belt on the small pulley to its circumference.

In some cases where the belt slips it is more advisable to face the pulleys with leather than to increase the tension.



Figs. 2 and 3

This will be found to give the belt 25 per cent. longer life and to increase the friction considerably.

Care of Belts

In buying a belt it is advisable to get it from a reliable firm and to make sure that it has a close fiber and is very pliable. The flesh side of a belt is always the stronger and is less liable to crack; therefore, it should be on the outside and not next to the pulley. Oil, water and dirt are injurious to a belt and should not come in contact with it at all. In moist places leather should not be used as it will stretch and rot. Where possible, belts should be run from the shaft in opposite directions to relieve the pressure on the bearings.

The Origin of Hydrocarbons

No problem in geology appears more complex than that of the origin of the numerous natural hydrocarbons—asphalt, ozokerite, petroleum and natural gas. In fact, geologists are at variance in their theories as to the manner in which these are produced. A great number of the more important hydrocarbons found in petroleums can be produced artificially from organic substances, such as coal, wood and fish oil, while identical or closely allied hydrocarbons result from the interaction of inorganic substances, such as cast iron and chlorhydric acid. In many places petroleum is closely associated with fossiliferous strata.

In Bulletin 401 of the United States Geological Survey, entitled "Relations between Local Magnetic Disturbances and the Genesis of Petroleum," by George F. Becker, the condition of knowledge of the origin of petroleum and other bituminous substances is reviewed. Some oils, says Mr. Becker, are undoubtedly organic and some are beyond question inorganic. They may have been derived from carbonaceous matter of vegetable or animal origin, and they may have been derived from carbides of iron or other metals. It is also barely possible that the hydrocarbons exist as such in the mass of the earth.

While studying the subject, Mr. Becker was led to inquire whether any relation could be detected between the behavior of the compass needle and the distribution of hydrocarbons. Not much could be expected from a comparison of these phenomena, for magnetite exerts an attraction on the needle whether this ore occurs in solid masses or is disseminated in massive rocks; moreover, many volcanic rocks possess polarity. On a map of the magnetic declination in the United States Mr. Becker found that the irregularities of the curves of equal declination of the compass were strongly marked in the principal oil regions. The most marked agreement is found through the great Appalachian oilfield, which is the area of greatest variation in declination. In California, also, strong deflections accompany the chain of hydrocarbon deposits.

These observations are to some extent also supported by conditions in the Caucasus, where great magnetic disturbances exist. While the theory of the inorganic origin of the hydrocarbons as exploited by various scientists is not proved by this study, yet the contention that great oil deposits are generated from iron carbides is strongly borne out by a study of the map of magnetic disturbances in the United States. The map shows that petroleum is intimately similar to those arising from the neighborhood of substances possessing sensible magnetic properties, such as iron, nickel, cobalt and magnetite.

Notes on Prime Movers

The prime motive-power committee of the National Electric Light Association was appointed some time ago to consult with manufacturers and station managers for the purpose of keeping in touch with the latest developments in the design and operation of prime movers and their auxiliaries. The report of this committee for 1911 contains some interesting information, extracts from which are herewith given.

Steam Turbines

Erosion and corrosion were observed in different types of turbines and in various localities, but do not appear to be common to any particular make nor to any known set of conditions.

The manufacturers point out that this action, which is apparently caused by water of condensation being thrown by the rotating element at a high velocity against the stationary parts, may appear extensive, yet do little harm. One instance is cited where the engineer believed it would be necessary to rebore the machine and reline it in order to restore the assumed loss in efficiency. But before doing this, tests were made to determine how much the efficiency had been affected and it was found that apparently the efficiency had not been impaired. The explanation given for this is that the slightly increased clearance over the ends of the moving buckets permitted the passage of water without causing friction. This seemed to indicate that clearance between the tips of the rotating buckets and the inner wall of the turbine casing is not detrimental to the efficiency of the machine, at least where water is present.

Regarding clearance, it was reported by one manufacturer that with the five-stage machine, when rubbing had occurred it had taken place almost invariably at the third stage. This indicated that possibly the clearance at this stage was insufficient, the practice having been to make this clearance the same as that on the first and second stages. As a result the minimum clearance is now employed on the first stage and is increased for each of the succeeding stages.

The Westinghouse Machine Company reported some departures in design, chief among which is the introduction of an impulse element for the first stage, followed by reaction elements for the rest of the machine. Also higher rotative speeds are being used, 3600 revolutions per minute being employed successfully up to capacities of 2500 kilowatts and 1500 to 1800 revolutions per minute for capacities up to 10,000 kilowatts. The higher speeds are accompanied by smaller dimensions and smaller parts which lessen the effect of distortion and permit a reduction in the clearance ratios.

The bleeder type of turbine has been designed for use in industrial plants or in combination power and heating plants where it is desired that a turbine shall operate with a good vacuum and also bypass a considerable quantity of steam from the lower stages for heating or other purposes.

Surface Condensers

Many central stations are so located that at certain seasons of the year the circulating water is heavily laden with refuse and foreign matter and obstructs the condenser tubes. One central station reported serious trouble of this kind which was remedied by converting the multipass condenser into one with a single pass. This change resulted in presenting three times the opening to the flow of water and reducing the path of the flow to one-third of the former distance. The same vacuum was maintained as before and the only appreciable effects, outside of practically eliminating the trouble, were those of a lower discharge-water temperature and a larger quantity of circulating water.

Reports from a large number of companies indicated that the majority of troubles with condenser tubes, such as pitting, breaking, etc., are confined to plants using sea water as the circulating medium. In some cases, however, where the water contains chemicals in solution or particles of carbon or iron oxide, a local galvanic action is set up between these and the zinc in the tubes. This once started means spots of carbon from which the zinc has been removed, and at such points the action goes on until there is a hole.

In some cases trouble was reported from the condenser tubes creeping endwise, this often being sufficient to wear away the shoulder on the gland and permit the tube to come out of the tube sheet. It would appear that this is caused by the high velocity of the steam, as the tubes which gave trouble were at the top of the condenser. A suggested cure for this trouble is to employ a special gland for these tubes, one that will screw into the tube sheet tightly, making a vacuum-tight joint without packing, with a groove on the inside of the gland next to the tube. The tube can then be rolled into the gland in a manner similar to that in which a boiler tube is expanded into the head.

Cylinder Oil

Much diversity appears in the practices of different companies regarding specifications for cylinder oil where superheated steam is used. The viscosity reported varies from 145 to 240, and the flash point from 531 to 660 degrees. It appears that the oils which should be avoided are those having an asphalt base, which tends to carbonize in the cylinders at high temperatures.

Saving Effected with Pumping Engine

By F. W. Salmon

The demand for water during the night was small and in order to keep the pump running, the bypasses were partly opened. This represented a waste of power. By an ingenious device this waste was measured and was found to be so great that steps were taken to dispose of the surplus water at a small profit.

At a small pumping station in a section of the country where coal is high, a high-duty crank and flywheel pumping engine was used to pump water directly into the city mains, the pressure being maintained nearly constant by a pressure-regulating governor. The speed of the engine varied greatly at different hours of the day and night, and during the night there was so little water used that it was often necessary to keep the bypasses partly open, connecting the discharge chamber with the pump cylinder and thus preventing the pump from stopping on dead center.

The chief engineer kept a log book in which, among other things, was recorded every hour the readings of the revolution counter. By subtracting successive

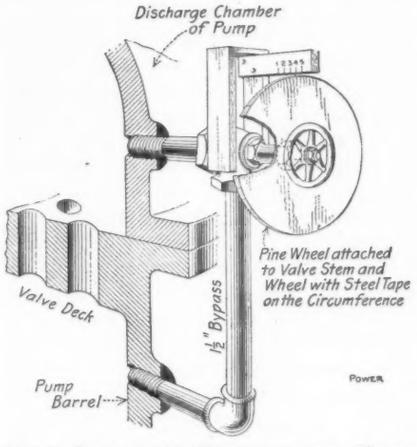

Discharge Chamber of Pump
Pine Wheel attached to Valve Stem and Wheel with Steel Tape on the Circumference
Valve Deck
½" Bypass
Pump Barrel
POWER

FIG. 1. DEVICE FOR MEASURING THE VALVE OPENING

readings the number of revolutions for any hour could be determined, and in this way it was discovered that during some hours of the night the engine made more revolutions than during certain hours of the day. This indicated clearly to the chief that his night assistant had been running with the bypasses open more than was necessary. Accordingly, he spoke to the night engineer about it but was assured that the valves on the bypasses were watched carefully and were never opened more than was necessary.

Although the apparent night pumpage did fall off a little after this, the chief was not satisfied; he wanted to know how much of this apparent pumpage was wasted power. This problem now confronted him: How could this be measured?

He reasoned that if it were possible to determine how much water was being used at night in the city, the difference between this and the apparent pumpage would represent the bypassed water or wasted power. A venturi meter would measure this, but the expense involved was too great; the game was not worth the candle. The chief then set about to accomplish the desired result with commercial accuracy for much less money; and he succeeded.

The pump had four cylinders to each of which was attached a 1½-inch bypass operated by a globe valve. The chief procured four steel tapes, each one meter long, and divided them into centimeters and millimeters. On the handwheels of the bypass valves he attached a wooden disk about 12½ inches in diameter and concentric with the spindle. Around this was wound the tape and the pointer was secured as shown in the sketch. The whole attachment cost less than $2 and it was possible to record the opening of each valve to 0.001 of a turn.

The next time that the load was put on the other pump, the chief had the crank and flywheel pump opened and examined carefully, the valves being tested with water under pressure from

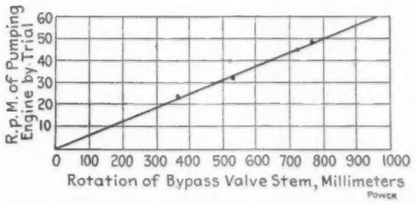


FIG. 2. CALIBRATION CHART FOR INDICATING DEVICE

the other pump. Finding everything tight, the bypasses were opened and the pump started, running at various speeds under the usual pressure of 110 pounds and regulating the speed by the bypass valves. The opening of each valve as shown by the pointer and steel tape was recorded for each speed. This was plotted as shown in Fig. 2. The pump was then put on the mains and the other pump was shut down.

That night the opening of each bypass was recorded with the readings of the revolution counter, and it was found that over one-half the water apparently pumped had passed back through the bypasses.

A few days later the president of the company strolled through the pumping station, and the chief showed him the data. When the president asked why the small direct-acting pump was not used for night service, he was told that the small pump had been found to take more steam with the bypasses shut than the large pump with the bypasses open. The chief suggested that the surplus water pumped at night might be sold, with profit, even at a low price.

Therefore, arrangements were made with the railroad company to supply its tank (used at night for filling the tenders of locomotives of freight trains) with water at about $900 per year. With this arrangement the total revolutions per day were only from 90 to 100 more than formerly.

At a recent meeting of the Physical Society of London, President H. L. Callendar described and gave a demonstration of the action of the electric thermo-regulator designed by him in 1897 for experiments by the continuous electric method on the specific heat of water. The same type of regulator is now being employed for measurements of the variation of the specific heat of water by a new method in which two steady streams at different temperatures are allowed to mix, or share their heat, the resulting temperature being observed.

A new chemical refrigeration process due to Doctor Repin, a French chemist, is claimed to be free from the defects of the ammonia process, and to be specially adapted for economical results in small plants. As is well known, in one of the methods of refrigeration at present in use, the cooling is effected by the evaporation of liquefied ammonia. The ammonia gas is recovered in water, which absorbs large volumes, and when the solution so formed is heated the ammonia is expelled into a cooled receiver and liquefied by its own pressure. A serious difficulty is that about 25 per cent. of water is carried with the ammonia from the solution. The new process, which is said to be free from this trouble, uses sulphur dioxide as a refrigerant and camphor as an absorbent, 20 per cent. of naphthol being added to the latter to prevent excessive foaming and melting of the camphor on heating. The sulphur dioxide is easily liquefied and absorbs much heat in evaporating, while it is entirely disengaged in gaseous form from the camphor solution at a temperature below the boiling point of water.—*The Engineer.*

Electrical Department

Especially conducted to be of interest and service to the men in charge of the electrical equipment

Care and Operation of Alternating Current Dynamos

By Norman G. Meade

All switches should be open when an alternator is not running. The machine should be clean and free from oil and dust at all times, especially from copper or carbon dust. With a high-voltage machine a small accumulation of dust on the windings may be the cause of a serious burnout. In stations of sufficient size to warrant the expense it is advisable to install an air pump with a line of piping to all machines; at each machine a short section of hose is attached to the pipe line to enable the attendant to reach all parts of the winding and blow out accumulations. The air pressure used for such service should not exceed 25 pounds per square inch; a higher pressure may disturb the insulation on the windings and blow dust into the coils. Any accumulation of moisture in the pipes must be blown out before turning the air on a machine.

Each machine should be given a thorough inspection occasionally. The higher the voltage of the alternator the more often should this be done.

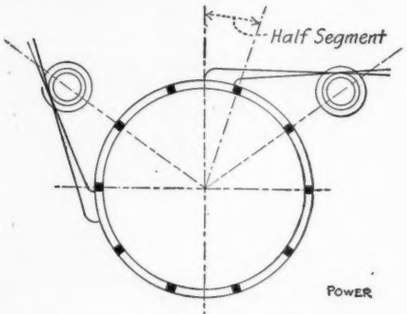
Ventilation

In their latest form, turbine-driven alternators are entirely inclosed. A fan in each end draws cool air from an outside source and forces it through and out of the machine by way of an outlet at the bottom of the frame. This air should be drawn through suitable piping from some source outside the building to eliminate dust and dirt and to secure a low temperature. Inclosed turbo-generators require about four cubic feet of air per minute for each kilowatt of capacity. The velocity of air in the intake pipe should be from 600 to 1000 feet per minute. Special precaution should be taken that the warm air from the machine does not escape into the intake passages. This ventilating arrangement serves the twofold purpose of keeping the machine cool and of preventing undue accumulations of dirt and oil.

It is advisable to remove the hoods over the ends of the machine at intervals and give the interior a thorough inspection and cleaning. The ventilating ducts in the field magnet which are parallel to the shaft are liable to become obstructed with oil-soaked dust. Care must be exercised to prevent the accumulation of dirt there because if the ducts become choked the revolving element will heat rapidly and the field winding may be damaged. When an ordinary air blast is not sufficient to remove the dirt, it must be forced out with a wire brush or rod. The radial air passages which lead to the periphery of the magnet are not usually subject to this difficulty because centrifugal force tends to keep the passages clear.

Brushes, Rings and Commutators

The collector rings must be kept clean, smooth and true. To prevent cutting, a little vaseline should be applied occasionally. The rectifying commutators of compensated alternators should be kept smooth by the occasional use of No. 00 sandpaper. Commutator lubricant should be applied to high-voltage alternators with a piece of cloth attached to the end of a dry stick. If the commutator becomes at all out of true it should be turned down. In the case of revolving-armature generators this can be done without removing the armature from the machine by the use of a special slide rest and by running the engine very slowly; or the commutator may be taken off the shaft and turned down in a lathe.



Setting of Rectifier Brushes

On most modern alternators carbon or soft graphitic brushes are used to conduct the exciting current to the collector rings. These brushes are usually mounted perpendicularly to the surfaces of the collector rings; they fit closely and require little attention beyond occasional renewal and casual inspection from time to time to see that they fit properly. Soft graphitic brushes have been found to give the best results as they are less likely to chatter.

On some of the older types of alternator copper brushes reinforced by brass plates are in use. Care must be taken to prevent the brass plates from coming in contact with the collector ring; if they do, cutting will result.

The copper brushes used in conjunction with the commutators of alternating-current generators with compensating windings are beveled and bent into proper shape before being shipped, as indicated in Fig. 1, which shows the correct setting of such brushes on a commutator with ten segments. The space between the brushes depends upon the location of the brush-holder studs. The brushes are set one, three, or five segments apart, on different machines; the operation of the commutator will be the same electrically as long as the brushes are an odd number of segments apart. The forward brush in each holder should be given a lead of about one-half a commutator segment ahead of its companion.

The brushes should bear upon the commutator with light but good contact, the leading brush having slightly less pressure than the trailing brush; too great a pressure will lead to heating and cutting. It is well to place one set of brushes a little further from the shaft bearing than the other in order that any ridges formed by one set will be worn away by the brushes of the other set before they become perceptible.

It is advisable to set the trailing brushes exactly in position while the generator is at rest, and when once set they should not be changed. Sparkless commutation can only be obtained when the brushes are set in this correct position. The leading brushes may be changed relatively to the trailing brushes while the machine is in operation.

The compounding of the alternator may be varied by shifting the brush-holder rocker and also, to a slight extent, by changing the spread of the brushes in each holder; increasing the spread decreases the compounding and *vice versa*. When the rocker is shifted to give the proper compounding, all brushes may be made to run sparkless by changing their spread. The practical limits of this adjustment are when the brushes span one commutator segment, in which case the compounding winding is short-circuited, and when all the brushes of each stud

are in line, in which case the compensating winding will be open-circuited.

If the generator is running on a non-inductive load or on a load with a constant power factor, the brushes may be permanently set for a given regulation. If, however, the power factor varies, it will be found necessary to adjust the brushes occasionally. The higher the power factor, the less compounding will be necessary for a given regulation and *vice versa*. With a widely varying inductive load it is impossible to adjust the brushes so as to obtain absolutely sparkless operation.

Sparking at the rectifying commutator may be due to any of the following causes: The brushes may not be set at the proper point for commutation; a position can always be found where there is no appreciable sparking and at this point the brushes should be secured. The brushes may be loose or may not be bearing sufficiently on the commutator, or may be welded at the end. They may be spread at the end, or the commutator may be rough. The commutator may be dirty or oily, or copper dust may have collected on the insulating segments. The generator may be overloaded. The compensating circuit may include a loose contact or be actually open.

Bearings

Modern alternators have self-oiling bearings. These should be filled to such a hight that the rings will carry sufficient oil up to the shaft. If the bearings are too full, oil will be thrown out at the ends. The oil should be renewed about once in six months, or oftener if it becomes dirty and causes the bearings to heat.

The bearings must be kept clean and free from grit. They should be frequently examined to see that the oil supply is properly maintained and that the oil rings do not stick. New oil should be run through a strainer if it appears to contain any foreign substance. If the oil is used a second time, it should first be filtered and, if warm, allowed to cool.

If a bearing becomes hot, heavy lubricant should be fed into it copiously and the nuts loosened on the bearing cap; if the machine is belt connected, the belt should be slackened.

Belts

The belt of a belt-driven alternator should be tight enough to run without slipping but the tension should not be too great or the bearings will heat. Belts should run with, not against the lapping. The joints should be dressed smooth so that there will be no jarring as it passes over the pulley. The crowns of driving and driven pulleys should be alike; "wabbling" of belts is sometimes caused by pulleys having unlike crowns. A wave motion or flapping is usually caused by slippage between the belt and pulley, resulting from grease spots, etc.; this fault may sometimes be corrected by increasing the tension but a better remedy is to clean the belt. A back-and-forth movement across the pulley face is caused by unequal stretching of the edges of the belt.

It sometimes occurs on belted machines, especially in dry weather, that charges of static electricity on the belt, which may be of quite a high potential, cause discharges to ground. If the frame is not grounded, these charges may jump to the armature or field winding and thence to the ground, puncturing the insulation.

General

If a line fuse blows or a circuit-breaker opens, the switch corresponding to that line should be opened and the fuse replaced or the circuit-breaker closed. The switch should then be closed. If the circuit opens the second time, there is something wrong on the line—probably a short-circuit—and this should be corrected at once. If a short-circuit occurs at or near the machine, or if an arc be formed at a switch or fuse block and holds on, all field-regulating resistance should be thrown in at the rheostats. If necessary, the field switch should be opened and if this does not stop the trouble the machine should be shut down at once.

Before starting up any alternator, it should be clean. The bearings should be well supplied with oil and the oil rings free to turn. The machine should be brought up to speed and the rheostat turned so that all the resistance is in the field circuit and the field switch closed. The rheostat of the exciter should be adjusted for the normal exciting voltage; then the voltage of the alternator raised point by point to its proper voltage by cutting out the resistance of its field rheostat. The load can then be thrown on.

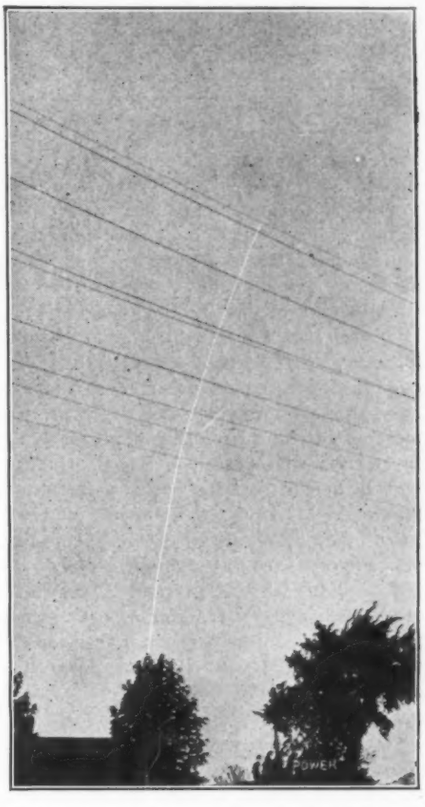
Any of the following causes may prevent an alternating-current generator from developing its normal electromotive force: The speed may be below normal; the switchboard instruments may be incorrect and the voltage may be higher than that indicated, or the current may be greater than is shown by the ammeter; the voltage of the exciter may be low because its speed is below normal or because its series field winding is reversed; the brushes of the exciter may be incorrectly set; a part of the field rheostat or other unnecessary resistance may be in the field circuit.

To shut down a machine operating alone, the field current should be reduced as much as possible by means of the field rheostat and the load thrown off by opening the feeder switches or main generator switch, if one be used. Next, the exciter circuit should be opened and finally the machine shut down.

Fishing Line and a Pheasant Cause Trouble

A peculiar cause of ground was recently found on a 66,000-volt line. The series relay at the station gave trouble during the early morning hours by coming out. The trouble patrol finally discovered that a fishing line had been hooked over one of the top wires and hung across several others, and touched the ground, as shown in the accompanying illustration. The wet condition of the fishing line, caused by the dampness of the night air, had reduced its electrical resistance sufficiently to enable the enormous electromotive force to drive through it an appreciable current to the ground; this leakage current had opened the relay.

It is the practice of the company operating these high-tension lines to send out a trouble man to locate any disturbance of the circuits. One evening the relay on one of the lines came out and the next day the trouble man discovered that a pheasant had, in flying between the wires, touched two of them with the tips of its wings and caused a slight short-circuit. The pheasant was instantly killed. The incident had been witnessed by a railroad employee, who took the bird home to furnish a portion of the evening meal. When the bird was cut open, however, it was found that the electrical current had turned the flesh green.



Position of Fishing Line that Caused the Trouble

Kilovolt Amperes

What and why are kilovolt-amperes? This question is asked at frequent intervals, notwithstanding Jones' painstaking efforts* to explain the effects of phase displacement in alternating-current circuits. Volt-amperes are volts × amperes and a kilovolt-ampere is 1000 volt-amperes, because kilo means a thousandfold.

In a direct-current circuit, volt-amperes are exactly the same as watts because the current and electromotive force are steady and it is therefore impossible for them to be out of phase with each other.

In an alternating-current circuit the volts and amperes rise and fall many times per second; if they rise and fall exactly in unison, both reaching their maximum values at the same instant, they are "in phase" and the power factor of the circuit is 100 per cent. That is, all of the power represented by the current and pressure is available power. Then, volts × amperes, or volt-amperes, are equal to watts; consequently, kilovolt-amperes are kilowatts.

When the current and pressure do not rise and fall exactly in step with each other, the power factor is less than 100 per cent. because when the current is maximum the voltage is not and when the voltage is highest the current is not; consequently the maximum combined effect of the two cannot be obtained and it is the *combined effect* that makes power. Pressure that exists today cannot be combined with current that exists tomorrow; similarly, pressure that exists at one moment cannot be combined with current that exists a hundredth of a second later.

If at one instant the pressure is at its maximum of, say, 100 volts and at that same instant the current has reached only 800 amperes, the *instantaneous* power is $100 \times 800 = 80{,}000$ watts. If the current reaches its maximum of 1000 amperes, say, when the pressure has dropped to 80 volts, the instantaneous power is again 80,000 watts. But under these conditions the maximum power of $100 \times 1000 = 100{,}000$ watts can never exist, because the pressure and voltage do not reach their highest values together.

The true power (watts) is the mean (the quadratic average) of the many instantaneous power values which exist during the alternations of the pressure and current. As the instantaneous power never reaches the possible maximum, the mean power cannot be the full value represented by merely multiplying the pressure and current together; that gives the volt-amperes and volt-amperes may or may not represent power. If a current of 1000 amperes lags behind a pressure of 100 volts by one-quarter of a cycle, there are 100,000 volt-amperes in the circuit but absolutely no available power because the power factor is then 0; when the pressure is maximum the current is at zero in its cycle and when the current is at its highest point the pressure is at zero.

The power factor of a circuit is the proportion of apparent power (volt-amperes) that is actual, available power (watts). If a current of 1000 amperes lags behind a pressure of 100 volts by a full tenth of a cycle, the power factor is 80 per cent. Therefore, although the volt-amperes are 100,000, the real power is only 80 per cent. of that, or 80,000 watts.

Having the usual voltmeter and ammeter together with either a wattmeter or a power-factor meter, the characteristics of a circuit can be determined, because

Volt-amperes × *Power factor* = *Watts*

and therefore

Watts ÷ *Volt-amperes* = *Power factor.*

In considering power-factor values it must be kept in mind that they are *percentages*. When anyone says the power factor is 80, he means 80 per cent., or $\frac{80}{100}$, and that means that the real watts in the circuit are $\frac{80}{100}$ of the apparent watts, or the volt-amperes.

*Pages 268, February 14, and 454, March 21, 1911.

LETTERS

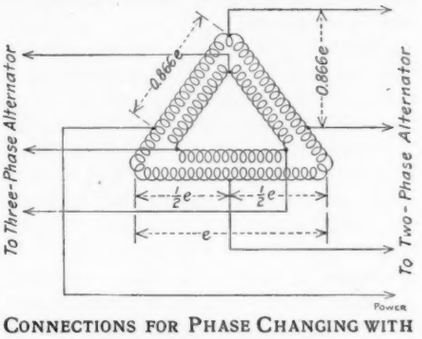
Two-phase and Three-phase Alternators in Parallel

Referring to D. M. Grove's recent inquiry as to whether he can operate a two-phase alternator and a three-phase alternator of the same voltage and frequency in parallel through a two-phase three-phase transformer, I wish to point out that there are several difficulties to be overcome in order to obtain reliable operation that way. The Scott connection of transformers shown in Mr. Grove's diagram gives voltages which are subject to distortion, not only when the secondary loads are unbalanced, but also with a balanced noninductive load; hence this method would be the source of more or less trouble.

The three-transformer arrangement for changing three-phases to two-phases, or *vice versa,* shown in the accompanying diagram, is superior to the two-transformer scheme in its greater freedom from unbalanced voltage and larger "factor of safety" for continuity of service. If one of the transformers of the Scott system should become inoperative, only one phase would remain active on either the two-phase or three-phase side; consequently, the whole system would be out of commission until a new transformer could be installed. Therefore, in order to insure continuity of service, a spare transformer must be carried in stock. If one of the transformers in the three-transformer system should become inoperative, the two remaining ones can be temporarily V-connected and will carry the load until the damaged one is repaired. If it should be considered preferable to keep a spare transformer in stock, its rating is only two-thirds that of a spare transformer for the two-transformer system.

When the three-transformer system is used, however, the armature windings of the two-phase generator must be independent, because destructive local currents would be produced in the windings if they were interconnected.

It is practical to operate the two machines in parallel with the field winding



CONNECTIONS FOR PHASE CHANGING WITH THREE TRANSFORMERS

of the two-phase machine left just as it is. Each machine will do its share of the work irrespective of what the field strength may be, the division of the load being determined by the relative free speeds of the prime movers.

In an ordinary alternator there are two sources of field excitation: the current in the field winding and the current in the armature winding. To produce a constant voltage the sum of these two excitations must be constant. Now the excitation due to the field winding of the two-phase machine varies with the load on account of the compensating winding, whereas variations in load will have no effect on the ampere-turns in the field winding of the three-phase machine. Hence, any changes in the load currents of the two machines will cause a cross current between the two armatures and circulating in the armature windings in such directions as to strengthen the field of the weaker machine and oppose the field magnetism of the stronger machine, thereby balancing the voltages of the two machines.

To eliminate cross currents, the field excitation of the three-phase machine will have to be adjusted to correspond with that of the two-phase machine, and if the variations in load are not too rapid or of too great magnitude, the attendant could do this by means of the field rheostat. However, for rapid variations in load it would be advisable to install a Tirrill voltage regulator in connection with the three-phase machine, adjusting the compensating winding of its alternating-current magnet to give the three-phase machine the same rate of compounding that the two-phase machine has.

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Gas Power Department

Everything worth while in the gas engine and producer industry will be treated here in a way that can be of use to practical men

Experiences with Large Gas Engines in Steel Works

During the sessions of the Gas Power Section of the American Society of Mechanical Engineers, at the recent Pittsburg meeting, there was a semi-informal and highly interesting discussion of the results obtained with large gas engines in steel works. The supervising engineers of several of the large plants of this country presented their views with an unusual degree of freedom and comprehensiveness. Very full abstracts of these utterances are given herewith.

BY E. A. MACCOUN*

It is on account of the large expense for repairs, high first cost and extra complications of gas engines that some steelworks managers hesitate to install more of them. Excellent results are being obtained in the way of reliability. During 1910 one of our 38x54 twin-tandem blowing engines ran 90.3 per cent. of the year and the other one 90 per cent.; the electric unit (40x54 twin-tandem engine) ran 75.87 per cent. of the year.

Figs. 1 to 12 inclusive show some of the improvements we have made in the constructional details of our engines. Cylinder troubles have not yet been entirely overcome. The greatest difficulty is the liability of the cylinder to crack and allow water to leak in from the jacket. Both iron and steel have been used for cylinder castings. I greatly prefer steel because of the thinner wall, which increases the cooling effect and thereby helps to prevent metal fatigue; but this does not eliminate the liability to crack.

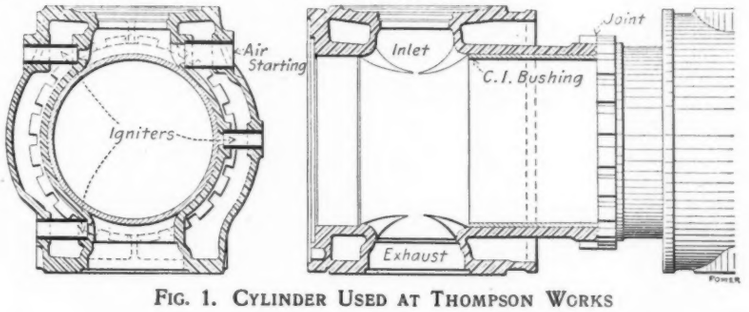


FIG. 1. CYLINDER USED AT THOMPSON WORKS

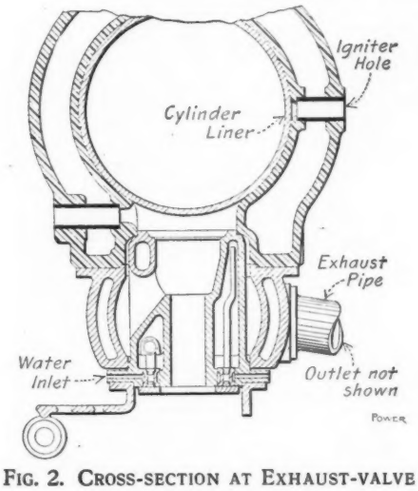


FIG. 2. CROSS-SECTION AT EXHAUST-VALVE CHAMBER

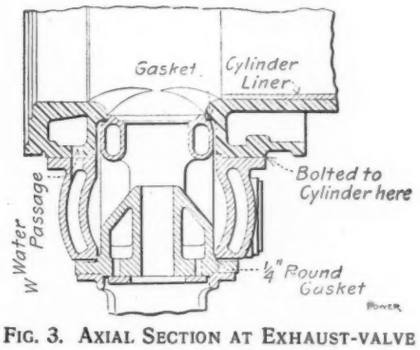


FIG. 3. AXIAL SECTION AT EXHAUST-VALVE CHAMBER

Fig. 1 illustrates the construction of a cast-steel cylinder we have had in service for two years and Figs. 2 and 3 are partial sections through the same cylinder.

Fig. 4 shows the type of piston now in use. It is made of cast steel and has never given any trouble. It will be noticed that its contour is an approach to a sphere; this gives enormous strength and allows for expansion. There is no agreement between builders as to the number or type of piston rings that should be used. We prefer to use not more than four rings of the sectional type, with keepers, with good depth and wearing surfaces. Rings should not be doweled in place, because the dowel pins are liable to come out and cut the cylinder wall.

It is most difficult to make a piston rod strong enough to stand the pressures developed in large engines. Some rods are as large as 13 inches in diameter and it is nearly impossible to increase the size to any great extent. Piston rods are fastened to crossheads by keys through the rods or by threads with either nuts or clamps over them. The thread with a clamp over it appears to be preferable; the keys and nuts have given considerable trouble. Nickel steel was first used in our piston rods but it was found unreliable. A more satisfactory material is open-hearth steel of the following composition:

	Per cent.
Carbon	0.45 to 0.60
Manganese	0.45 to 0.60
Phosphorus	under 0.04
Sulphur	under 0.04
Silicon	0.10 to 0.20

This steel to be heated to get 50,000 pounds per square inch elastic limit, 95,000 pounds ultimate strength and 12 per cent. elongation in 2 inches. No trouble has been experienced by the wearing of rods made of this steel. We have been compelled to line all piston rods with brass tubing on account of the acid in the cooling water, taken from the Monongahela river. We had to abandon holes through the sides of the rods for

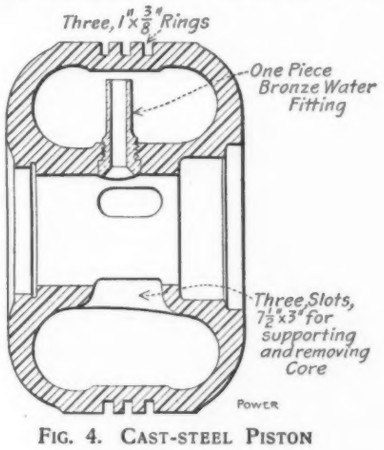


FIG. 4. CAST-STEEL PISTON

*Superintendent of furnaces, Edgar Thompson Steel Works, Braddock, Penn.

the entry and exit of water on account of the cracks that developed; the water is taken in and discharged through the ends of the rods. Figs. 5, 6 and 7 show the constructional details of the picton rods and connections now in use, which seem to be satisfactory.

The cylinder heads gave some trouble at first, but this has been eliminated by changing the design as illustrated in Figs. 8 and 9.

Many improvements can be made in the inlet-valve gears of engines working on blast-furnace gas. The essential requirements for satisfactory working are as follows: The wear on all parts should be taken up easily by adjustment; ample surfaces should be provided on all wearing parts to prevent rapid wear and distortion of the valve setting; each valve on the engine should be adjustable independently of all the others; the valve gear should be so made that the relative openings of the gas and air ports can be changed either individually or collectively, and it should be possible to make these adjustments very quickly, to meet sudden changes in the quality of the gas.

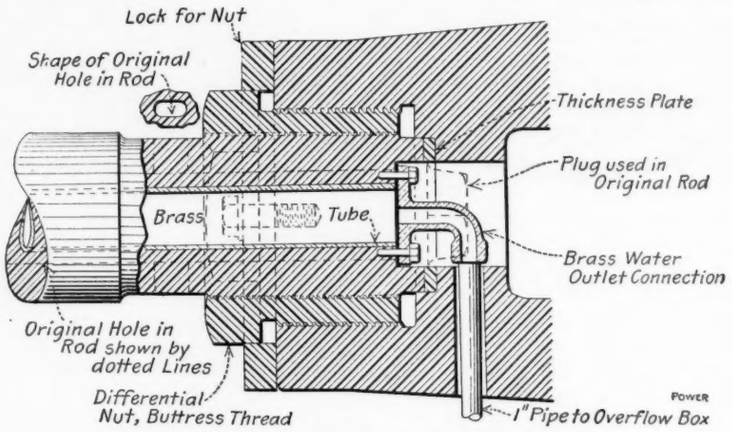

Lock for Nut
Shape of Original Hole in Rod
Thickness Plate
Plug used in Original Rod
Brass Tube
Brass Water Outlet Connection
Original Hole in Rod shown by dotted Lines
Differential Nut, Buttress Thread
1" Pipe to Overflow Box
POWER

FIG. 5. IMPROVED PISTON-ROD CONNECTIONS

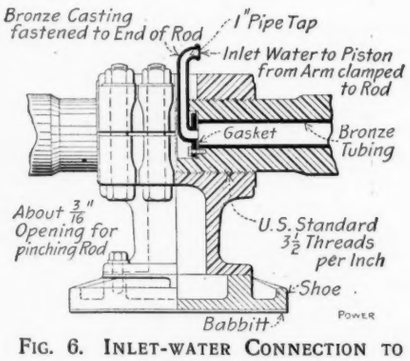


FIG. 6. INLET-WATER CONNECTION TO PISTON ROD

Many of the valve gears now in use meet most of these requirements but none of them, so far as I know, satisfactorily meets the last one, which is very important.

We have found the constant-compression system of governing better for all load conditions than constant mixture. Figs. 10 and 11 are diagrams taken from engines using the two systems, ranging from no load to full load.

Our exhaust valves have given very little trouble and do not have to be ground in very often. Fig. 12 shows the valve in use on our engines.

BY R. H. STEVENS*

At the Carrie furnaces we have four Allis-Chalmers gas-blowing units and five electric units; three of the latter engines are Allis-Chalmers and two of the Bethlehem Steel Company's make. The gas from the furnaces first goes through a Babbit impinging washer; then through a fan into a screen, from the screen into the Theisen washer and thence to the engines. We get a total efficiency in the cleaning of over 99 per cent.; the impurities are reduced as low as $\frac{3}{1000}$ of a grain per cubic foot. Our engines take about 110 to 120 cubic feet of gas per indicated horsepower and the gas ranges from 85 to 90 B.t.u. per cubic foot.

Our gas blowers have been in shape to operate at least 95 to 98 per cent. of the time that has elapsed since they started. The demand, however, was such that we only ran approximately about 90 per cent. of the elapsed time. We are getting gas that is cleaner than the air. We do not use the fans in connection with the cleaning system; we bypass them.

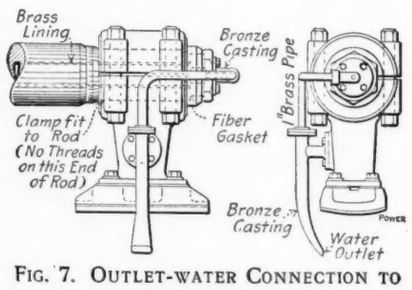


FIG. 7. OUTLET-WATER CONNECTION TO PISTON ROD

*Mechanical engineer, Homestead Steel Works.

BY A. M. DIEHL*

Blast-furnace gas after leaving the furnace passes first through the dust catcher, where the heavier particles are deposited by their own weight, which is facilitated by the reduction in the velocity of the gas. Beyond this point, a number of washing systems of cleaning have been proposed, but none of them is very efficient unless used as an auxiliary to a cooling apparatus for the removal of moisture, because the temperature is so great that the gas will pick up moisture again and the good effect of clean gas is destroyed by the excessive moisture.

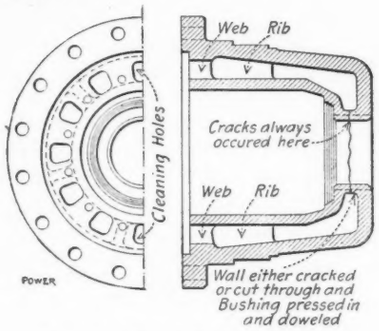


FIG. 8. OLD CYLINDER HEAD

We have obtained the best results by positive and repeated spraying in a tower 76 feet high and 12 feet in diameter, supplied with water at one level about 10 feet from the bottom and at another about 30 feet higher. At each level the water is fed into a distributing valve having a revolving core which is rotated by a 5-horsepower motor. The two valves are located outside the tower and each has 12 openings from which 1¼-inch pipes extend to spray nozzles in the tower. These nozzles are located so as to cover the entire cross-section of the tower; they point upward and deliver the water against a screen about 6 inches above them which breaks the water up into a fine mist.

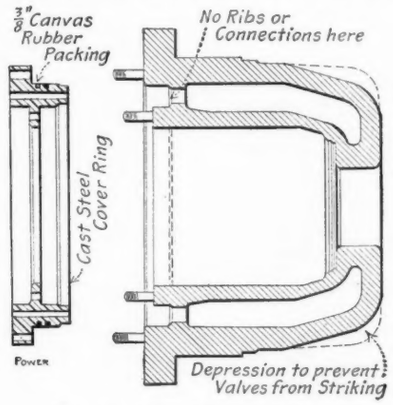

⅜" Canvas Rubber Packing
No Ribs or Connections here
Cast Steel Cover Ring
POWER
Depression to prevent Valves from Striking

FIG. 9. NEW CYLINDER HEAD

The core of each distributing valve always closes two of the openings and

*Superintendent of furnaces, Duquesne works of the Carnegie Steel Company.

leaves the other ten open and its rotary motion causes the openings to be closed successively in pairs. At the moment when one pair of nozzles is shut off, the gas surges through the space around them because of the lower resistance there to its passage; a moment later these nozzles are opened again and the next pair closed, and the renewed sprays pass through the gas above them and tend to drive the column over to the area belonging to the nozzles that are now shut off. This tends to give the ascending column of gas a spiral motion which increases the efficiency of the scrubbing.

A speed rate of 15 revolutions per minute is about right for the distributing valves. The upper and lower valves are arranged to overlap each other. This arrangement has proved superior to a revolving spray located at the top of the tower, in both cleansing and cooling ability. From the towers the gas passes to Theisen washers, thence to a spiral drier and to the main leading to the engines.

The engine equipment consists of two twin-tandem Snow power engines and four blowing units; all of the cylinders are 42x60 inches. The electric generators are rated at 2000 kilowatts each and on an average load of 1372 kilowatts during the last six months of 1910 the engines showed an average thermal efficiency of 24.15 per cent.

The engines are cleaned about once every two months; we have never stopped an engine to clean the cylinders or pistons, but the jackets become clogged with mud and leaves from the river and when we clean them the cylinders and pistons are also cleaned. About once every six hours two charges are allowed to blow off through ports located in the bottoms of the cylinders.

During the past six months the engines have operated 98.8 per cent. of the time that they were actually required (not the elapsed time), but less than one-half of 1 per cent. of the time loss was due to the engines themselves, the remainder being due to the blowing-tub drive.

Some of the constructional features that gave trouble in this plant are giving satisfaction in other places. The changes that were made are as follows:

The piston cooling water connections changed from swinging joints to telescopic joints; igniters changed from rotary to vertical motion (this restricts the location of the igniter to the top of the cylinder); spur gears put in place of spiral gears to drive the cam shaft; connections between exhaust valves and mufflers provided with expansion joints; piston changed from cast iron to steel and rings changed to eliminate the keepers that held the rings in place (these keepers caused cylinder cutting which necessitated the bushing of three cylinders); piston-rod packing rings made of babbitt instead of cast iron, except the

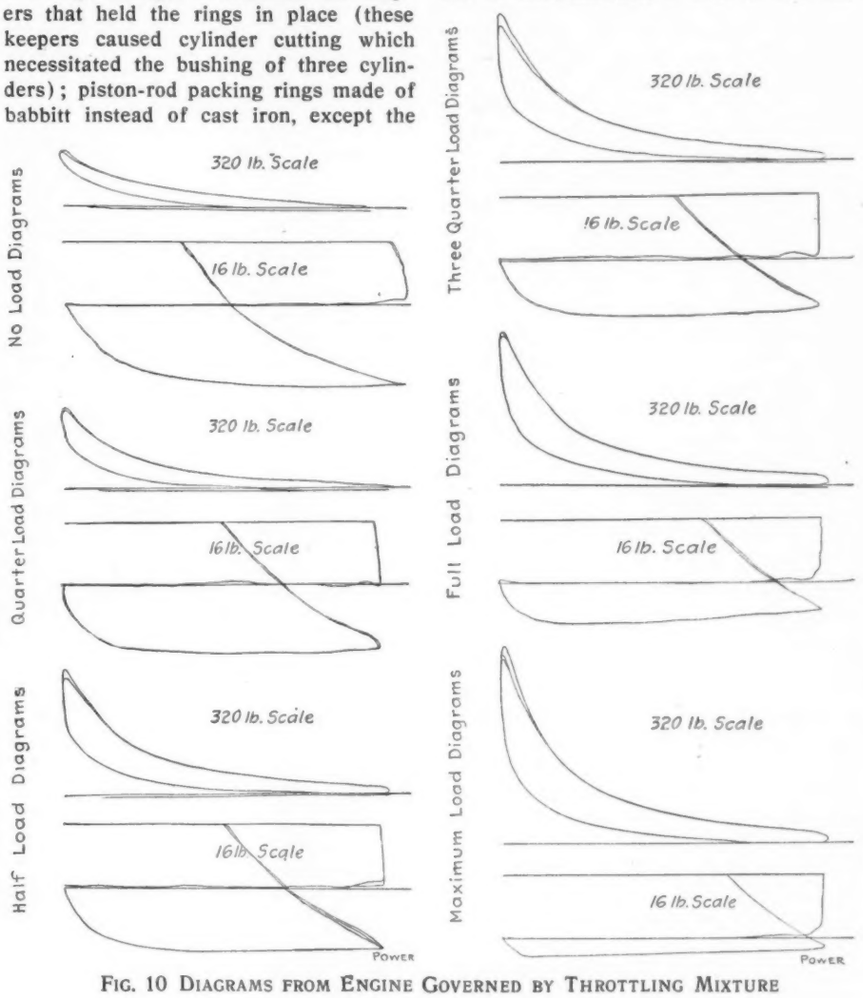


FIG. 10 DIAGRAMS FROM ENGINE GOVERNED BY THROTTLING MIXTURE

BY H. L. HOERR†

The National Tube Company's plant at McKeesport contains two twin-tandem Allis-Chalmers engines with cylinders 32 inches bore and 42 inches stroke, each driving a 1000-kilowatt electric generator at 110 revolutions per minute. The dynamos are direct-current machines and are operated in parallel with others driven by steam engines.

Many difficulties were encountered at first and for a while the situation was discouraging. After making a good many changes in the engines, most of them slight, they are operating as regularly as any of the other units in the plant.

†Steam and hydraulic engineer, National Tube Company, McKeesport, Penn.

"fire" ring; a slight change in the form of the exhaust-valve chamber to prevent internal stresses in the castings.

During 1910 one engine ran 89 per cent. and the other 91 per cent. of the total elapsed time, and there were four months when no delays were chargeable to the former engine and six such months for the latter one.

The gas is practically free from dust when it leaves the final Theisen washer; a sample of 100 cubic feet contained only 0.23 of a grain, total. The water used by the gas-cleansing plant averages 105.7 gallons per 1000 cubic feet of gas cleansed.

I would like to add that the good practice which obtains at the plant should not be construed as meaning that a gas engine is necessarily the proper prime mover for such a works. I am inclined to believe, without having definite and complete data, that the cost of the gas engine in the first place and the cost of its maintenance in the second place are so heavy that steam can still compete with it very successfully in the districts where coal is cheap. I am not able to submit detailed figures to prove this, but in order that the figures and the facts given in the operation of this plant may not be misconstrued, I wish to add the opinion that we can still use steam in this district at a lower cost than for gas power.

BY H. J. K. FREYN‡

The previous speakers have tried to convey the idea that possibly the gas engine was not the right one to use, but in the same breath they gave us figures like 95 and 99 per cent. running time and said no delays were charged to them for six months and four months, and so forth.

In the Gary plant, on the shore of Lake Michigan, which is driven entirely by gas

‡Assistant engineer of construction, Illinois Steel Company, South Chicago, Ill.

engines, only 25 per cent. of all delays have been charged against the engines. The engines have run on an average service factor of 33 per cent., which is about equal to the service factor of any of the large power plants in New York, Boston or Chicago. I am unfortunately not in a position to give you today any actual figures relative to the cost of operating these gas engines, but I can tell you that when the Gary plant is compared with a big steam-turbine plant having a service factor of 30 to 38 per cent., the cost of operation at Gary looks very, very good, notwithstanding the fact that the American gas engine is a very recent development in the line of prime movers.

The assistant general superintendent of the Illinois Steel Company recently went to Europe and while there he saw the blast-furnace gas-engine installation at a large German steel plant. When he returned he expressed the opinion that we are mere amateurs in gas-engine work in this country. He told me that there was a marked lack of trouble; there was in fact no trouble at all. I was in Europe last year after an absence of four years and I was surprised to see how wonderfully the gas-engine installations operated. The gas-engine development started in Europe about 1899, and I had the pleasure of being connected with the birth of the large gas engine. Five or six years ago, in an assemblage like this you could have heard exactly the same things we have heard about cylinders cracking, piston rods breaking and all kinds of troubles, but if you go over there today you will not hear anything about those troubles, because they have been worked out in the meantime. The gas engine is not as far advanced in America as in Europe, because only four or five years have elapsed since the first large gas engine was installed and operated here.

Mr. MacCoun seems to think that gas engines are successful only in smaller sizes; there are in operation abroad gas engines of 48 inches cylinder diameter and 55 inches stroke, running at 80 to 90 revolutions per minute. I have seen a twin-tandem double-acting gas-engine unit of 4000 kilowatts operating on blast-furnace gas.

The cost of repairs is very high, and we have had a lot of trouble. We admit it. But the latest installations of large gas engines—the Snow engines at South Chicago and Duquesne and the Allis-Chalmers and Westinghouse engines at Gary—are operating without any big repairs; the cost of repairs and of operation is coming down here just as it has in Europe.

Mr. MacCoun said it is almost impossible to design piston rods strong enough to stand the terrific strain of gas-engine work. American piston rods are 28 to 33 per cent. of the diameter of the cylinder; in Germany they are not more than 25 or 26 per cent. There are nickel-steel piston rods over there containing as much as 5 per cent. nickel, which would be considered absolutely prohibitive in this country.

Many constructional details which have given trouble in this country have never given any in Europe; the only difference is in the workmanship. What we need in this country is better workmanship, and there is no doubt that we are going to get it.

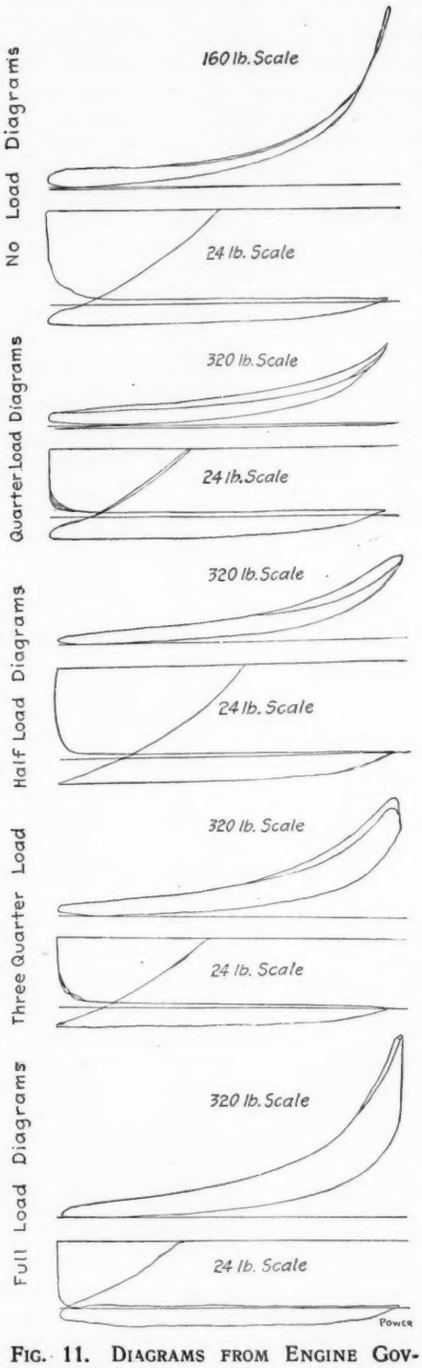


FIG. 11. DIAGRAMS FROM ENGINE GOVERNED BY CHANGING MIXTURE QUALITY

There have been a great many cases in this country of large cast-iron cylinders cracking. So they did in Europe. The solution in this country seemed to be to put in cast-steel cylinders, and there are several in successful operation. There is not a single steel cylinder in use in Europe, even in 48-inch diameters. The reason, as far as I can learn, is that the foundry practice over there is a little different and better than here. The steel cylinder has not met with great success abroad, because of the fact that while the modulus of elasticity of cast steel is much higher than that of cast iron, the coefficient of elongation by temperature is very much higher. The product of the two factors, which is called the coefficient of quality, is therefore about the same for the two metals. In other words, the greater elongation due to temperature in the steel cylinder offsets the superiority in the modulus of elasticity.

We have also arrived at the cast-steel piston in this country, and I fully share the views of everybody in regard to the use of cast steel. Therefore I was surprised to see 48-inch cast-iron pistons in use abroad without cracking.

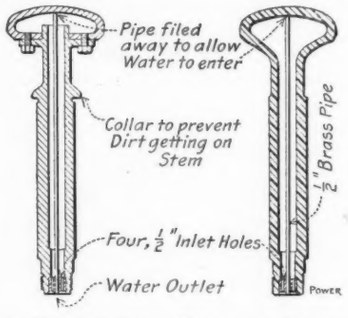

Pipe filed away to allow Water to enter
Collar to prevent Dirt getting on Stem
½" Brass Pipe
Four, ½" Inlet Holes
Water Outlet
Power

FIG. 12. IMPROVED FORMS OF EXHAUST VALVE

The packing of piston rods has given a great deal of trouble in this country, but the packings now made are good and I believe we are ahead of the Europeans on the packing question, because, while European packings are doing well, they are very complicated.

I used to be a very stanch adherent of the constant-compression or "quality" principle of regulation, but I do not think it is much of a system now, since I have seen engines in operation with variable compression, running electric generators without any pounding and without any trouble.

Mr. Bacon, of the Illinois Steel Company, and I have investigated the comparative costs of installing gas-power and steam-power plants, and while we cannot give out the results now, I can tell you that statements that have been circulated to the effect that the cost of a gas-power installation is $125 a kilowatt are not true at all. The cost of a gas-engine plant is unquestionably higher than that of either a steam-turbine or a steam-engine installation, but the cost of fuel is considerably lower for the gas engine; therefore, the total operating

cost, including fixed charges, compares very favorably with steam turbines and engines.

In the matter of gas cleaning we are far ahead of European practice. In gas-engine plants operated in connection with steel companies in this country, there is no trouble at all with dirt in the gas. Our engines are not cleaned once a year. The other day I pulled out a cylinder head on one of our old Allis-Chalmers gas-blowing engines and it was absolutely polished like a piece of glass; the amount of dirt in the cylinder head and on the piston and in the counterbore was not enough to make a handful and there was almost no carbon to be seen. The amount of dust in the cleaned gas is about 0.009 grain per cubic foot. The cleaning plant will keep the dust down to 0.01 of a grain under all conditions, and the engine builders do not require less than 0.02 of a grain.

The cost of installing some gas-power plants is higher than it ought to be because the gas-cleaning plants are more expensive than they need to be. The explanation of this needless expense is that at first nobody knew much about gas cleaning and they wanted to be safe, therefore, they installed more capacity and more machinery than was necessary.

When the Gary plant was started up, no provision was made for a proper supply of ignition current. The ignition system was supplied from the general lighting system through a motor-generator set. This was, of course, a very careless thing to do, because in case the power went off, the ignition failed and all the engines went down. I should advocate for any gas-power installation an independent storage battery to supply ignition current. The utilization of waste heat from gas engines has made a great deal of headway in Europe. Tests made in a plant in Belgium showed that about 13 per cent. of the power of the engine can be realized from the waste heat in the exhaust and the cooling water by generating low-pressure steam and using it in turbines.

Although it may be true that with cheap coal the steam turbine and the gas engine are about alike in total operating costs, a steel plant needs a great deal of electric power which it cannot get in any other way but by using its gas or burning coal. Any blast-furnace plant which does not have to supply electric power for a steel plant and in which the gas therefore has no value, is justified in putting in steam turbines for blowers, etc. But any large blast-furnace plant connected with a steel plant, where large amounts of power are needed, cannot afford to put in anything else but gas-engine blowing and electric units because of the amount of power that can be generated from the gas that is saved, due to the better efficiency of those engines.

By E. Friedlander*

The largest gas engine built today is entirely too small for a large power station. To produce power and sell it, we shall have to go to larger units, as has been proved by the New York and Chicago stations, which have put in 20,000-kilowatt units. The speed of the gas engine is too low. In the Corliss engine only the valve gear limits the speed; we all know that the flywheel, the shaft and the piston and rods do not limit the speed. A large engine can be built strong enough to run at 150 revolutions per minute so far as the shaft, the flywheel and other main parts are concerned; the difficulty is all in the valve gear. Now the valve gear of a gas engine runs at only one-half the speed that it does in a steam engine, so I do not see why we cannot increase the speed of the engine.

A very serious point is the class of labor required for operating the gas engine. It should not be necessary to provide a better class of labor to operate these engines than is ordinarily employed in power stations; that means that all complicated mechanisms should be omitted.

A gas engine cannot be overloaded if it is properly rated. It cannot develop more than the power represented by a full charge of mixture and that is the actual full load of the engine. Overload ability is a matter of arbitrary rating; to get 10 per cent. "overload," the engine must be rated at 90.91 per cent. of its real full-load ability. This lack of overload ability is a serious thing. The amount of overload capacity in electric central stations is always taken into consideration when figuring on the size of the station's equipment.

There is another point in connection with overload. Gas engines are very slow in taking their proportion of a fluctuating load; they always lag behind the other prime movers, especially turbines. This is probably caused by having to take in a charge, compress it and explode it; the effect of the governor movement cannot be immediate. Because of this sluggish response to load changes it is advisable to install some turbines in any large alternating-current station driven by gas engines and supplying a lot of induction motors.

In our district more shutdowns and delays are chargeable to faulty cooling than to any other cause. This is due more to local conditions than to engine construction. The cooling water is gritty and contains free sulphuric acid and iron sulphate, which will attack any metal, especially steel forgings and piping. For handling such water, all forgings, such as exhaust valves and stems, and piston rods, should be lined with noncorrosive material and the piping made of brass or copper except in the large sizes; cast iron will do for those.

Ignition has given very little cause for complaint. The mechanical make-and-break igniter with forged steel contact points requires the least attention and is far ahead of the electromagnetically operated igniter. Each igniter should be wired up independent of the others, with its own fuse of four times the normal current capacity.

The lubrication of gas-engine cylinders has not been generally satisfactory. The manner of admitting the oil into the cylinder is just as important as the quality and quantity of oil used. The oil must be spread over the surface of the cylinder wall and this is preferably accomplished by pumping it in with the mixture or as soon as possible after the scavenging of the cylinder, spreading it during the compression stroke and leaving the cylinder lubricated for the power stroke. Oil should never be admitted during the power stroke and it should not drop on the piston as soon as it enters the cylinder but should have time to run down the wall on each side before it is spread by the piston rings. We have found it satisfactory to provide two holes in the top half of each end of the cylinder barrel, about 40 to 60 degrees apart; this location does not permit the oil to drop off to the bottom of the cylinder nor does it leave a dry spot on the top of the wall between the oil holes. This method has been used on our engines for the past three years.

By Prof. Charles L. W. Trinks*

It is possible to push the gas engine up to the highest notch of economy by designing it for minimum friction and throttling losses—using a long stroke and slow rotative speed. Such an engine, however, would be prohibitive in price. The slow-speed blast-furnace gas engine has 2½ times the efficiency of a steam engine or turbine and it would be better to sacrifice some of this and reduce the cost of construction about 25 per cent.

The advantages of increasing the rotative speed are very great; the horsepower of the engine is increased almost without additional cost and the first cost of the electric generator is reduced. With alternating-current generators, the number of field-magnet poles would be reduced and parallel operation thereby made easier.

It may be supposed that higher speeds will decrease the economy without increasing the power very much because the cylinder will not take in a full charge of mixture. Examination of a curve showing the relation between brake horsepower and average pressure in the cylinder during the suction stroke will correct this impression.

*Superintendent, electrical department; Edgar Thompson Steel Works.

*Professor of mechanical engineering, Carnegie Technical Schools, Pittsburg.

Readers with Something to Say

Practical information from the man on the job. A letter good enough to print here will be paid for. Ideas, not mere words wanted

Engineering in the Oilfields

Some years ago, while employed in the field by a large oil company, I set up a locomotive type of boiler which was to be used to steam oil. It carried a steam pressure of 60 pounds. After connecting the ball-and-lever safety valve it was my intention to lead the discharge outside of the boiler room, but my shift ended before this connection was made. The boiler was fired up that night, and the next day when about to put a nipple in the safety valve I found a plug screwed into the opening. I was told that the valve blew off and filled the boiler room full of steam.

A few days later I saw something hanging from the crown sheet of the boiler where the fusible plug should have been. I found a piece of ¾-inch pipe, welded at one end, screwed into the hole intended for the fusible plug; the fusible plug had burned out. I removed the gas-pipe plug and put in a fusible plug, and later on got another job.

B. F. HARTLEY.

Tipton, Cal.

Oil Drip Pans

I recently visited several engine rooms and noted that oil-soaked floors and numerous oil pans were features which did much to mar the otherwise neat appearance of nearly every plant I saw.

One floor was so saturated with oil that an attempt to walk across it was hazardous. The others invited improvement.

Oil pans surrounding an engine are an eyesore, although in most cases a few are necessary.

I have succeeded in reducing the number of drip pans in my plant from six to three, and hope to dispense with one of these soon.

An oil guard, made of sheet iron, painted the color of the engine, and encircling the eccentrics for nearly one-half their circumference, took the place of two pans. The guard is secured to the pedestal of the main bearing by brackets and has two slots through which the eccentric rods pass. The oil is carried away through a small pipe.

The pan that caught the drip from the governor was exchanged for a small sheet of iron, fastened out of sight underneath the engine frame.

I believe that grease cups are the best thing out for crosshead pins.

Grease is suitable in some cases for crank-pin lubrication, but I would hesitate about changing where a good centrifugal oiler was in use.

It was once the practice to lubricate bearings just enough to run them without excessive heating and the oil then used was allowed to go to waste. Now it is more economical to use a liberal amount of oil which can be saved and used again many times.

L. W. ROY.

Ware, Mass.

Has Poor Draft

The accompanying illustration shows how the smoke connections are made to my three boilers. For some reason the draft in the furnaces is not as strong as I think it should be and I would like some reader to point out the fault.

The boilers are each 72 inches in diameter, 16 feet in length and contain

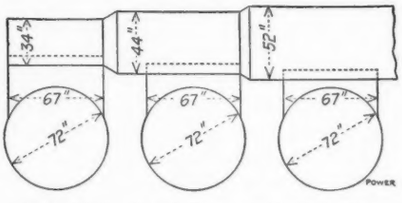


DIAGRAM OF SMOKE CONNECTIONS

seventy 4-inch tubes. The distance between the back wall and the end of boiler is 15 inches, that between the flue doors and front head is 17 inches. The connection between the smoke flue is 10 inches by 67 inches. The header is round and is 34 inches in diameter over the first boiler, 44 inches over the second and 52 inches over the third, and continues in this size until it reaches the stack, which is placed 12 feet from the last boiler.

The stack is 54 inches in diameter and is 80 feet high above the grates. The herring-bone grate bars contain 33 square feet. I use a very slow-burning, dry, bituminous coal and am compelled to carry a thick fuel bed. For that reason I need better draft than I now have. How can it be improved?

L. P. COTTON.

Lawton, Okla.

Drawing on a Crank Disk

At a cold-storage warehouse I had to remove a loose crank disk from a pair of engines. A ram and supports were rigged up, and the largest bolts available were 2⅞ inches in diameter. I had no trouble in removing the old disk, but the builders gave us about 0.007 to draw over the shaft on the new disk, and the threads were sheared entirely off the bolts before the disk had been forced on one inch. I next borrowed some 4-inch bolts 60 inches long, and managed to draw the disk into place.

In allowing the disk to stand still while I took up the nuts to avoid changing the jack and get more leverage, I was afraid I could not start it again, but the engine operated nicely and gave no further trouble.

The manager of the company said he was positive we had made a mistake in boring the hole for the crank shaft in the disk as he had measured it and knew it was much too small.

D. L. FAGNAN.

New York City.

Isolated Plant Held Its Own

I have read many articles of how the engineer should lend a helping hand to his brothers and, by helping others, help himself. I have wondered who among the engineering profession is in a position better qualified to show the brother engineer in the isolated plant where his mistakes and wastes are (if he cannot see them himself), than the central-station man. But he profits by the isolated-plant engineer's ignorance or neglect. He gets what data he can on an isolated plant and then will go to the isolated-plant owner with a bunch of figures telling him that he can furnish heat, power and light so much cheaper than his engineer is doing. The central-station engineer's job depends on all the business he can control, and the bigger the works the bigger the pay. One instance where a central-station man unsuccessfully attempted ousting an isolated-plant engineer is worth mentioning. The central-station company got permission to run a test to show the isolated-plant manager where he was losing

through his steam plant and how it would pay to install central-station power.

The isolated-plant engineer was a man of brains, and when the men from the central plant began the test, he determined to assist in every way he could.

After running the test it was found that the isolated man had the best of the situation.

B. P. PAGE.

Keshena, Wis.

Misplaced Injector Suction Pipe

An engineer bought a 2-inch injector coupled up in the usual way, the lift of which was about 6 feet. He was unable, however, to get it to work and I was called in to look it over.

I found that the suction pipe of the injector ran to a hotwell in which a ⅛-inch copper drip pipe from the pump steam chest discharged at the inlet of the injector suction. Steam bubbles were given off which destroyed the injector vacuum, thus preventing its working.

I changed the suction pipe of the injector to the other side of the hotwell, which removed the trouble.

H. POTTER.

Montreal, Can.

Gasket Punch

A pocket knife is generally used when cutting holes in rubber or leather gaskets. This method produces poor results.

In order to get good holes quickly, take a pipe nipple of proper size and grind it to a cutting edge. As there are about as many pipe sizes as bolt sizes, there is no difficulty in making any size of punch.

F. W. BENTLEY, JR.

Huron, S. D.

Expensive Economy

A certain power plant was installed a few years ago and, with few exceptions, the equipment was of the best and was carefully erected.

The roof of the engine room, however, was made of 2-inch planking, supported by steel truss beams. The planking was covered with tar paper and gravel. The exhaust pipe extended up through the roof and supported a type of exhaust head which threw the oil and water all over the roof. This soon so softened the paper that when it rained the engines got the benefit. A rough shelter had been built over the dynamo to protect it from the wet, and the only dry place in the plant was at the switchboard, the part of the roof over it being out of reach of the exhaust head. As if to remedy this the blowoff from the oil separator was piped to a barrel set on the roof directly over the switchboard. The action of the sun on the barrel soon caused this section of the roof to leak as badly as any other part. A cover was erected over the switchboard and the engineer could, while standing in a puddle of water, reach in and operate the switches, etc.

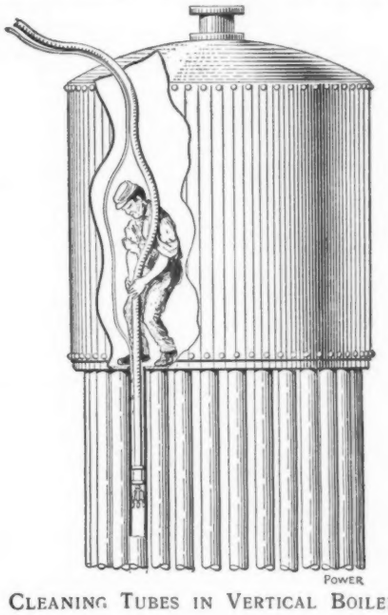
When the float in the open heater wore out, a square one was made out of sheet iron, this being considered cheaper than a round one of copper. This lasted about three days before it collapsed. Three others were tried and lasted about the same length of time. When the last one collapsed the attendant was busy elsewhere. The power engine was flooded, breaking the main bearing and damaging the armature winding. The accident caused a shutdown of three working days for 100 men and it cost $85 to patch things up.

F. MORSE.

Edmonton, Can.

Tube Cleaning Kink

The illustration shows an outline of a vertical boiler which is operated in this vicinity. It had not had the flues cleaned for a long time and a flue cleaner was ordered. In cleaning, the operator must stand on the upper drum and feed his cleaner down. Because the operator must be confined in the drum, a steam-driven machine was out of the question.



CLEANING TUBES IN VERTICAL BOILER

Water was not available in sufficient quantities at the required pressure, so an air machine was used.

The machine arrived and, superintended by the engineer and several others, the work was commenced. The machine ran fine, but after several tubes had been cleaned the dust in the drum became too much for the fireman doing the job. Covering all the tubes excepting the one on which he was working helped matters some, but was not sufficient. Stopping them up tight with plugs stopped the dust all right but unfortunately the draft also, and the drum of the still warm boiler became unbearable.

The fireman finally discovered a remedy himself. He took a small hose into the drum with him and let a very small amount of water trickle into the tube on top of his cleaner. This stopped the trouble completely and as far as I can see did no harm to the machine.

JOHN BAILEY.

Milwaukee, Wis.

Lubricator Condensing Chamber

If the reader will examine the sight-feed lubricator on his pump or engine he will see a round, polished, hollow chamber on top of the lubricator. Why is it there? What does it do? What is it good for? Is it in the right place? Lubricator manufacturers will state that it is a "condensing chamber."

What does it condense? The common double-connection lubricator feeds oil into the steam pipe only because the ¼-inch or ⅜-inch pipe leading from the lubricator upward and tapped into the steam pipe above the instrument is full of water—condensed steam.

If this pipe is full of water, the so called condenser is full of water also and does no condensing. It does act as a condenser when first put into operation, but as soon as it becomes full of water, the ¼-inch pipe does all the condensing after that.

No one can give a valid reason why the so called condensing chamber is located where it is; it is simply a matter of custom, like many other things.

The proper way to connect up a lubricator is to remove this chamber and put it at the top of the pipe where it can be a real condensing chamber.

G. H. WALLACE.

Racine, Wis.

Obtaining Information from the Chief

If the young engineer or fireman shows that he is interested in his work and will go to the chief, when he is not too busy, he will generally get the information he desires.

About two years ago I was with a chief engineer, in a large steam-electric power plant, and assisted in lining up a new high-pressure cylinder on a cross-compound engine. When the job was finished I stood by on the night shift while trying out the new cylinder.

When ready to indicate, the chief sent for me and explained the details of indicating in such a comprehensive manner that, with my theoretical information and experience with diagrams taken from simple slide-valve engines, I could understand the matter thoroughly.

The chief who gave me the diagram information was called "big-headed," "hard-hearted" and "nigger driver"; and that it was only by the aid of his as-

sistants that he could hold a position, but most of his "stand bys" were either discharged or resigned and he has been promoted from chief engineer to superintendent of construction of power plants.

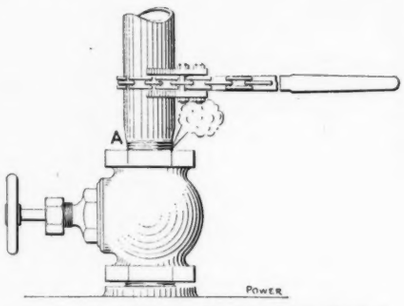
But when the progressive engineer is promoted his troubles begin. Sometimes the employees take advantage and make trouble, and in some cases infer that the newly promoted engineer is to blame. I have had this happen to me on two or three occasions.

WILLIAM PIPER.

Salt Lake City, Utah.

Careless Use of Chain Tongs

The careless use of the chain pipe tongs is the cause of many permanent leaks in steam-pipe lines. The accompanying illustration shows a common result caused by the careless placing of the pipe wrench when putting up the



LEAK CAUSED BY CHAIN PIPE TONGS

work and bending the pipe, as shown at *A*. This causes a leak at the joint.

Had the chain tongs been placed in the position shown in the illustration, there would have been no leak at the throttle, even though the chain tongs did crush the pipe.

C. R. MCGAHEY.

Baltimore, Md.

Drill for Brickwork

An easy means of drilling holes through a brick wall is to take a piece of gas pipe the desired length and cut a sawtooth edge on the end. It is then put in the fire and flared out enough for clearance.

Next take a piece of light cast iron and bring it to the melting point, and, having the pipe as hot as possible without danger of burning, hold it in the molten metal and cover the end with a thin layer of cast iron. Then dip it in cold water. With a little practice one can make a first-class pipe drill that will stand a lot of abuse.

FRED W. SMITH.

Dixon, Ill.

Plugged Blowoff Pipe

The blowoff pipe of a boiler became plugged. The difficulty was overcome by attaching a strong hose to the feed-pump discharged pipe and to the end of the blowoff pipe. Then the blowoff valve was opened and the feed pump started for a few seconds with the feed valves closed. When the hose was disconnected the pipe was found to have been freed from its obstruction; thus a shutdown was avoided.

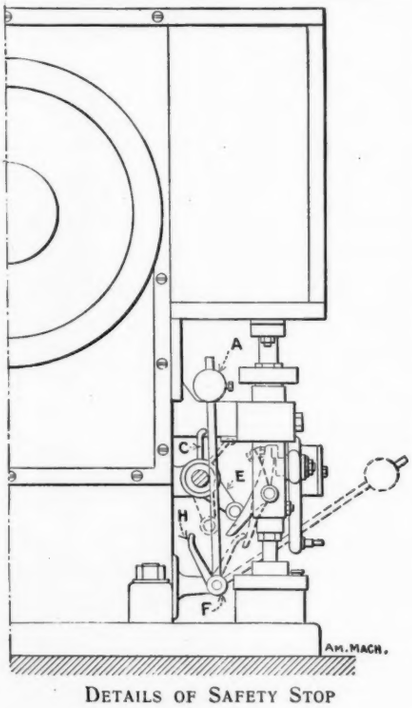
ROY W. LYMAN.

Ware, Mass.

Engine Safety Stop

The accompanying illustration shows a safety device I made and used successfully on an engine with no means of stopping automatically should the governor belt break.

This simple device when not in service is shown at *A*; it leans just enough to the left to prevent its falling over to the position shown by the dotted line. The knockoff-bell crank *E* has a pin *C* in the top, with the end turned to come against the upright rod when the ball *A* is on top. As the bell crank moves down, the pin *C* will force the lever and ball slightly forward, when it will fall in the position shown by the dotted lines; the arm *H* bearing against the catch-block



DETAILS OF SAFETY STOP

arm keeps the latter from hooking on and lifting the valve.

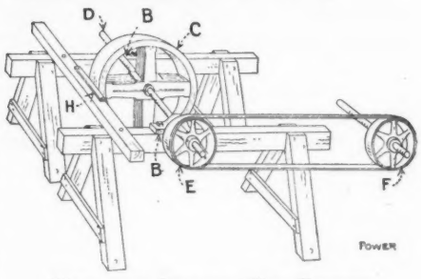
The bell crank *E* travels up and down as the governor rises and falls and a pin in the end of *E* bears against the tail of the catch-block arm and, forcing in the lower end, trips the valve. When the governor belt breaks, the governor moves the bottom of the bell crank *E* toward the cylinder, but the part with the pin *C* travels away from the cylinder. The pin coming against the upright rod tips it over to the position shown by the dotted lines. The shaft *F*, on which is attached a similar lever at the crank end, extends to the opposite end of the cylinder.

A. C. WALDRON.

Revere, Mass.

Makeshift Pulley Lathe

Some years ago in a little shop which built machinery and did repair work, a job would frequently come in that would require some queer manœuvering.



HOW THE PULLEY WAS TURNED

One day it was necessary to turn several large wooden sheaves. As no lathe in the shop could turn sheaves over 3 feet in diameter, the job was done as follows: Two ordinary carpenters' horses were procured upon which were bolted the bearings *B B*. The sheave *C* was mounted on a short shaft *D*, which was then placed in the bearings.

The pulley *E* was put on the shaft on the outside of one bearing. The two horses were placed close together so as to bring the pulley *E* in line with the pulley *F*, which happened to be a small pulley on the end of the engine shaft. After securing the horses to the floor the belt was put on the pulley and a piece of wood nailed across from one to the other, as at *H*, to which a piece of iron was fastened for a tool rest. After slowing the engine down to a suitable speed and using a heavy hand gage over the tool rest *H* the groove in the sheave was turned out as well as could be done anywhere.

GEORGE J. LITTLE.

Passaic, N. J.

Broken Flange Repaired

An engineer, in tightening up the nuts on a flange joint, broke out a part of the flange.

In making the repair it was decided to shrink a ring on around the flange. The ring was made out of a 5/8-inch square iron bar and bedded down to the flange, being drawn slightly to allow for shrinkage. The ring was then heated and forced on, the broken part of the flange being kept in place by a pair of tongs gripping a stud that was in a bolt hole.

JOHN S. LEESE.

Manchester, Eng.

Questions Before the House

Comment, criticism, suggestions and debate upon various articles, letters and editorials which have appeared in previous issues

Vacuum Increased by Reducing Pump Speed

In the April 25 issue, C. D. Eldredge cites an instance where he increased the vacuum in a condenser from 26½ to 28½ inches merely by reducing the speed of the rotary pump from 72 to 44 revolutions per minute. While at first glance this may seem very problematical, his conditions may be such that, if they were known, the reasons for this rather startling result would be quite simple. For instance, it is possible that he was putting a great deal of entrained air with the water into the condenser, which would militate greatly against a good vacuum, or it may be that the discharge from the pump was either throttled or too small, so that he really did not get the quantity of water he supposed with the pump running at 72 revolutions per minute. There are other possibilities in connection with the case that might explain it. It would prove of interest to hear further from Mr. Eldredge in the way of a brief description of his condensing plant, giving the type of condenser, amount of water pumped, steam condensed, etc.

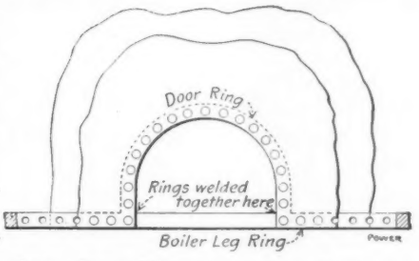
EVERARD BROWN.

Pittsburg, Penn.

Inspectors Disagree

Joseph King, on page 846 of the May 30 issue, seems much disturbed over the nonagreement of the State and insurance inspectors over examining a certain boiler of the original Manning design; and he infers that as the State inspector had ordered the most extensive repairs, he should be credited with the best inspection. In the first place, it should be understood that there can be no real controversy between the State inspectors and the insurance inspectors in the State of Massachusetts, for the insurance inspectors are all examined and issued certificates of competency by the State authorities before being permitted to do inspection work in the State; they are therefore practically State representatives in the performance of their duties. Any conflict in opinions between inspectors in Massachusetts is merely individual difference of opinion. The department is excellently administered by its chief inspector, who sees to it that the opinion of the individual does not interfere with obtaining safe and practical results through the inspection service.

Mr. King is evidently unfamiliar with the subject of boiler repairs, or he would not criticize the variations in these inspections in favor of the State inspector's report as he gives it. Putting in a new set of tubes and a new door ring for a boiler of the type described would be prohibitive for a boiler 21 years old; such repairs would cost about as much as a new boiler. The type of door ring referred to is the same as illustrated in



DOOR RING WELDED TO LEG RING OF BOILER

the sketch, the U-shaped door ring being welded to the leg ring of the boiler; the section of the leg ring across the bottom of the door serves only to prevent distortion of the furnace sheets adjacent to the door opening, the action being similar to that in the spring of a steam gage. If this portion of the leg ring is damaged and can be stiffened by patching, as called for by the insurance inspector, such repair is all that can be required for safety. It is, of course, folly for anyone, without seeing the boiler, to say whether it was necessary to remove 10 tubes or the whole set to make this boiler safe for further operation. In making an inspection it is, of course, much simpler to say remove all the tubes than it is to select a certain 10 tubes for removal and let the balance remain in service, and this without further evidence in the matter would lead me to believe that the insurance inspector had made the more careful examination of the two. The matter of whether one or two patches should be required at the sides of the fire door is probably not of serious moment, as such patches were probably required to remove fire-cracked portions of the original furnace sheet and to stop leakage, and their application had very little bearing on the immediate future safety of the boiler. It would seem that Mr. King is trying to make a mountain out of a molehill and in doing so is allowing his zeal to run away with his better judgment.

J. E. TERMAN.

New Haven, Conn.

Coal Defined

Referring to the article headed "Coal Defined," in the May 30 number of POWER, I would suggest that both gentlemen stick to the Century dictionary or some other modern dictionary and leave out any such confusing term as "pure coal." Why not arrange Mr. Bement's Table 2 as follows:

PROXIMATE COMPOSITION OF COAL

Coal = Dry Coal + Water.
Dry Coal = Coal — Water = Combustible Elements + Noncombustible Elements.
Combustible Elements = Volatile and Nonvolatile Combustible Elements.
Noncombustible Elements = Ash + Volatile Noncombustible Elements.
Ash = Any Solids Remaining after Complete Combustion.
Volatile Noncombustible Elements = Those Volatiles Driven Off during Combustion without Chemical Change.
Coal = Nonvolatile Combustible Elements + Volatile Combustible Elements + Volatile Noncombustible Elements + Ash + Water.

JOHN CLARKE WATSON.

Joliet, Ill.

Power Plant Betterment

Referring to the paper presented to the congress of technology by H. H. Hunt at Boston on April 11 and published in the May 2 issue of POWER, in the second paragraph Mr. Hunt states that a casual inspection of a small plant will often reveal a more or less heterogeneous collection of apparatus and machinery, some of which dates back to an early date. This, he declares, together with the fact that such a plant is usually operated by a force of engineers and firemen of only ordinary intelligence and ability, might naturally lead to the conclusion that, even under the most favorable conditions, high power cost is to be expected. It is my opinion that if Mr. Hunt will go into some of these plants he will be surprised to find that they are not run so badly or operated by such an ignorant force as he attempts to make us believe and that the economy and service are not so far behind that of the more modern station of the same size. Is it not because things are well run and taken care of that the manage-

ment hesitates to throw out the old equipment and put in new?

As to the men being of only ordinary intelligence and ability I think his remarks are not well founded. Many of the engineers in these "antiquated" stations are studying modern engineering methods, and are getting as much out of their plants as it is possible to get in order to make a good showing in comparison with the more modern plants. Another thing to be said for these men is that they usually have more difficulties to meet and repairs to make than do the engineers in the more modern plants. I question very much whether there are many of the experts Mr. Hunt refers to who could give these engineers many especially valuable pointers. It certainly does not require an expert to point out that there are leaky flues, incorrect gages or dirty boilers, and I do not believe Mr. Hunt will find many plants where such conditions exist or would be allowed to exist by a management which is progressive enough to look into such things and consider calling in an expert. I think that the management would first get rid of the slack engineer and get a competent one, and when this had been done there would not be any need of the expert.

As to engine valves, most engineers possess an indicator and know how to use it. I do not believe that there are many engineers, even in old plants, who need to be taught how to set the valves of their engines.

In one place Mr. Hunt says that the station should be thoroughly cleaned—as though the average engineer has not self-respect or brains enough to keep his station clean.

As to maintaining a steady steam pressure, I want to state right here that I can produce some steam-line diagrams that almost conform to a true circle and my plant is of the kind to which he refers, excepting the condition.

Mr. Hunt assumes that the engineers understand how to start and stop their engines but leaves us to infer that the expert would have to let them know when the light- and heavy-load periods came on so that they would know when to change over.

As to checking up the coal, I am afraid that he will have to do some hunting for plants in which they are not keeping close records of the coal consumption, output, cost per kilowatt, etc. The average chief engineer can usually run evaporation tests to determine the best fuel to be used, and the best methods of firing it. Here, again, it is hard to see why an expert should be called in to do this and to advise the installation of a CO_2 recorder when the fee saved would almost pay for one.

Mr. Hunt goes on to show that after all the expert does and suggests, the economy of the plant is liable to decrease and that an expert should be called in periodically to check things up. In other words, I infer from what he says regarding the upward tendency of wages that in his opinion power-plant owners should get cheap engineers and then have the expert come around occasionally and fix things up. I am happy to say that I do not believe that there is a very large field for this kind of expert, as the average present-day power-plant owner usually gets an uptodate engineer who will keep his plant in first-class condition at all times.

W. F. Cox.

Vicksburg, Miss.

Rolling Boiler Tubes

Letters have appeared in the columns of POWER from time to time concerning the proper way in which to roll boiler tubes so as to make them tight and at the same time avoid cutting them on the edges of the tube sheet at the point where they pass through it.

I believe that a good rule to follow in doing this is to set out the expander gradually and continue rolling until the tube feels smooth to the touch inside, opposite to where it bears against the sheet. This will make a tight tube and there will be little danger of cutting if the rolling process is stopped when this point is reached.

On examining the ends of old tubes they are frequently found to be cut almost through at some points in their circumference. This is done in most cases by the mandrel of the expander having been driven too hard and not turned enough before the rollers were again set out.

S. Kirlin.

New York City.

High Pressure Drips

Victor Bonn in the May 23 issue has misquoted my letter of April 11. If he will read it carefully he will see his mistake. He states that he never ran across such an arrangement as to drain high-pressure condensation into the low-pressure receiver. I stated in my letter that the condensation from the high-pressure discharge was connected into a pipe that drained the condensation of the working steam in the receiver to a trap. The pipe that drains the receiver of condensation to the trap performs the same function as a vapor pipe.

Mr. Bonn says there are a number of high-pressure traps where he is employed and he finds that the drip-return pipes are quite cold a short distance from the trap. I will agree with him on that statement, for at the plant where I am employed we have a number of traps that are the same, but they have not much work to perform. We have others located from 50 to 100 feet from the hotwell where they discharge, and the return pipe at the hotwell is so hot that a hand cannot be held on them. These traps are in good working condition.

Some time ago at this plant a new hotwell tank was installed at a different place from the old one. The drip returns from all steam traps were discharged into the hotwell above the water line. There was so much liberated steam from the returns that the water in the hotwell could not be seen and in the room where it was located it made the atmosphere hot and suffocating. To overcome this difficulty, the discharge from the drip returns was extended below the water line. The vapor from the drip returns is now condensed by the water in the hotwell.

From my experience and observation with high-pressure drips, I think Mr. Meinzer was justified in making the change.

R. E. Enigne.

Kansas City, Mo.

Constant Receiver Pressure

I would like to ask Mr. Johnson, who writes on constant receiver pressure in the May 16 issue, if he ever ran a compound engine carrying the following loads: A street railway, a number of dock-unloading machines, bridge cranes and ore and coal car unloaders; or a rolling-mill engine direct connected to a three-high ruffing roll, where one instant the full load is on and the next instant is off.

If Mr. Johnson ever had to get regulation on an engine running under the above conditions, he would readily see the necessity of a constant receiver pressure and avoid a larger hole in his coal pile.

Again, what has the receiver pressure got to do with the governor revolving in its highest plane? If he calls it engineering to have one cylinder doing more work than the other, perhaps he will explain where he gets his economy. He says that the engineer's problem is to keep the wheels turning with as little coal consumption as possible; and it goes without saying that with the shortest cutoff in the high-pressure cylinder the steam consumption will be least. Mr. Johnson says nothing about regulation. Whether he has to maintain a 2 or a 10 per cent. regulation each side of normal. If he will stop to consider, he will readily see that with a constant receiver pressure, and with the cutoff so adjusted as to equally balance the load; the low pressure will at all times be doing its share of the work and the high-pressure cylinder has less to do, and it will cut off earlier in the stroke.

W. R. Beard.

Cleveland, O.

The Screw Pump

In the May 30 issue of POWER, George H. Thomas has asked for further information regarding the screw pump. In this plant, where I have been in charge for over five years, our pumping installation consists of three screw pumps, four duplex steam pumps, one single steam pump, two triplex pumps and two multiple-stage turbine centrifugal pumps. Of this collection of pumping machinery I have become extremely partial to the screw pumps, as they have required very little attention and have given unusually good and constant service since their installation. By referring to the cut, the reader will see that the only packing necessary is at the points *A* and *B* on the outer ends of the shafts. The packing is applied on the suction side only, and does not have to withstand the high pressure of the discharge, the screws themselves obviating the necessity of packing on the high-pressure side.

As the only service of the packing is to seal up the suction end of the pump, it is put in very loosely. And from personal experience the writer has found that the packing can be done while the pump is in operation by reducing the suction until the weight on the suction chamber is equal to the atmospheric pressure. Four or five hours of time and about three or four pounds of ⅜-inch packing per year have been found to be all that is necessary to pack one of the pumps, handling between 600 and 800 gallons of water per minute for twelve hours a day and six days a week. The pumps require repacking about once in from four to six months with an addition of a ring or two about once in six weeks to two months.

If the packing in a screw pump is pulled up too tight, it will show signs of heating before any frictional load can be detected on the ammeter.

When the pump is lifting water the duty of the packing is to keep the suction from drawing air through the packing glands instead of stopping water from leaking.

We had an interesting experience at one time. The suction had become partly clogged up and one packing-gland seat had become worn so that the suction pulled the packing into the pump and drew in so much air that it was necessary to leave a ¼-inch pet cock open on the top of the elevator pressure tank the balance of the day to keep the tank from accumulating too much air.

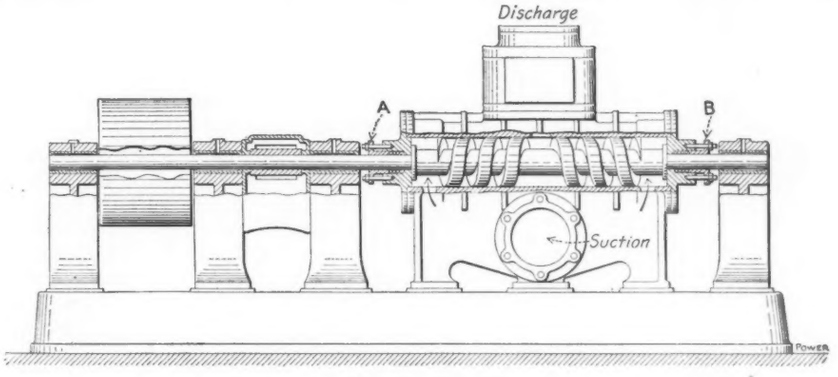
This type of pump is oiled by the ring-oiling system and requires the same attention that an electric motor does. It is our custom to fill the reservoirs each morning, which is sufficient for the day. The gears are run in an oil bath.

Another feature the writer appreciates in the screw pump is that the packing does not in any way affect its efficiency. If the packing leaks a little, it means only a loss of water before the work is applied to it, while with the plunger pump leaking of the packing is a loss of work. If submerged, the screw pump would need no packing at all.

L. M. JOHNSON.

Glenfield, Penn.

In the May 30 issue of POWER I noticed inquiries by George H. Thomas on page 849, relative to screw pumps. I know of a plant in which there is a screw pump used for a plunger elevator, and upon inquiry learned the following:



LONGITUDINAL SECTION THROUGH SCREW PUMP

This pump must be shut down while being packed, but it requires very little time to complete the job and so there is no need of waiting for a Sunday to pack it. It is about two years since this pump was packed and the packing shows no sign of giving out. Of course, a good quality of packing was used and the expense is small. No trouble is had in keeping the packing tight, and there is no undue friction of the parts. Concerning the lubrication, I would say that the cups and receptacles are filled once every week, and excepting the general attention that is given everything in the plant at all times, no special care is given this pump.

CHARLES J. MASON.

Scranton, Penn.

Sulphur for Hot Bearings

I could never see anything in the use of sulphur for hot bearings. I have seen it tried and also have tested it myself with no good results. A bearing can always be cooled by the use of mechanical skill with the file and scraper. There are times, of course, when it is necessary to keep running. I think that Mr. McDermid's suggestion of brine cooling is good. I have cooled bearings with castile soap and salt as well. There are cases where a fine powder, such as Bon Ami, will help, but lots of good oil should be used, as it will be found that the grains will grind into the metal and generate heat. It should never be used on a babbitt bearing, but on bronze and steel will do good work.

C. R. MCGAHEY.

Baltimore, Md.

Mr. McDermid's experience with sulphur in a hot bearing, described in the May 30 issue, is enlightening and would seem to eliminate that material from the list of useful articles for that purpose. However, it is possible that this material may have been used by others more successfully in a different manner, and a further discussion of this and other methods by the engineers would perhaps be of interest to many.

I have heard of a variety of things that are good for hot bearings, such as soap, soapstone, sapolio, rotten-stone, sulphur water, molasses, white lead, castor oil and white lead and graphite.

Of these I have personally tested graphite and, while it is a good lubricant under some circumstances, it appears, when mixed with oil and poured into a hot bearing to form a sort of dry coating or gum upon the bearing surfaces, and perhaps for that reason does not cool the bearing as rapidly as other methods.

Castor oil is very good where the operator has discovered the hot bearing before smoking occurs.

The most successful way I have found to cool an excessively hot bearing is to connect a hose and allow a small stream of clear, cool water to flow through it, using no other lubricant for the time being. Water containing sand or mud should not be used. Ice or snow packed around the bearing will materially assist in the cooling process.

After the temperature has been reduced to the point of safety a mixture of white lead and cylinder oil, say a pound of lead to a quart of oil, can be poured in a little at a time and good results will almost invariably follow.

Water used in a bearing will make a rough surface on the wearing parts while the white lead, being very mildly abrasive, will tend to smooth and polish. The two treatments combined as above are analogous to the method of original-

ly finishing the shaft or pin in the lathe by using first coarse abrasives and then finer.

Where it is impracticable or unsafe to use water, on electrical machinery, for instance, large quantities of ice-cooled oil poured in and allowed to run out of the reservoir generally gives good results.

In those journals having a large oil box in the cap, untried tallow may be packed in a manner not to intefere with the regular lubricating arrangements. If the journal heats, the tallow will melt and save the box frequently and the operator will in all probability smell the heated tallow in time to save trouble.

I have heard of a grease made of white lead being used by some engineers and graphite in cases of chronic heating, and I would be interested to hear of some personal experiences with this method.

F. C. HOLLY.

Yazoo City, Miss.

I read with much interest in the May 30 issue of POWER, page 849, H. B. McDermid's letter on "Sulphur for Hot Bearings."

Some time ago we had trouble in our mill with a hot box on one of the main line shafts, carrying a rope drive and transmitting 400 horsepower with a side pull. The shaft is 5 inches in diameter and perfectly in line and level. It ran so hot that we kept a man tending it for more than a week, and alternated with water and oil to keep the mill running. Between runs we tried the Sapolio and oil remedy, as well as everything we could think of or ever heard of (except the sulphur remedy), with no effect whatever.

The master mechanic had a new and longer box made and put in the hanger, hoping that the increased bearing surface would help it, but it ran just as hot as it did before.

The next morning the master mechanic got up on the staging and watched the bearing as it worked and noticed that the oil seemed to come out of the end of the bearing at the point of contact which was about one inch above the joint between the bearing and the cap of the box. This led him to believe that the oil was not being properly distributed over the bearing surface.

That evening he ordered the box taken down, and with No. 1 sandpaper he went over that part of the shaft inclosed by the bearing lengthwise. The shaft was then wiped clean, the box put back and the oil chamber filled with oil (for this was a ring-oiling box).

The next morning we started up. The man was at his post to nurse that hot box, but it did not get hot. The bearing has given perfect satisfaction ever since.

JAMES MITCHELL.

North Adams, Mass.

Central Station versus Isolated Plant

The discussion of the subject "Central Station versus Isolated Plant," which has been running in POWER for some time, interested me very much as the central-station people have made a bid to take over the plant in which I am employed. Our plant consists of one 150-horsepower Corliss engine, one 40-kilowatt direct-connected high-speed engine and generator, one large steam pump and several small pumps.

We use practically all of the exhaust steam for heating and manufacturing, about six months of the year, and from 30 to 40 per cent. during the balance of the year.

The Corliss engine carries a fairly constant load of from 125 to 150 horsepower, winter and summer. The high-speed set has a load of about 15 kilowatts through the summer months and about 40 kilowatts in the winter.

The central-station man looked over our plant and made inquiries about the amount of steam used for heating and other purposes aside from that used for power alone. Finding that our engines were acting as reducing valves between the boilers and the heating system for the greater part of the time, the power being obtained as a byproduct, as one might say, he told us that he could not save us anything by installing motors to run on central-station current.

I am constantly endeavoring to improve my plant and run it as economically as conditions will allow. I have asked for a new generator to be run by a belt connected to the Corliss engine which is belted to the line shaft.

This will allow the direct-connected set to be shut down a good part of the time except in winter and as the Corliss is considerably more economical than the high-speed engine we expect to make a little saving. A 15-kilowatt generator will handle the day load nicely but to provide for an increase in the future we will put in a 20- or 25-kilowatt machine.

We are also considering putting in a large power pump to take the place of the present steam pump, retaining the steam machine to use in case of a breakdown.

The addition of the power pump will give the Corliss a fair load and tend to improve its economy. In case the engine becomes overloaded we can start either or both of the other machines to relieve it. To furnish steam we have three horizontal return-tubular boilers rated at 70 horsepower each. At present we are burning from 15 to 16 short tons of New River coal per week, and furnish steam for from 160 to 175 horsepower. The running time is 56 hours per week. I figure that the steam pump takes at least three times as much steam per horsepower-hour as the engine and charge the steam to it at that rate. We have four or five motors of from 3 to 10 horsepower each which are used mostly for overtime work; the high-speed engine comes in handy at such times.

Where steam is used for heating and manufacturing to such an extent the central station cannot compete.

I. P. EIMES.

Lowell, Mass.

It is with considerable interest that I have followed the letters in POWER on the subject of the relative merits of central-station and isolated-plant service.

All of the articles I have read, on both sides, have treated the matter from the same viewpoint, that of cost. While this is, and no doubt will continue to be, the determining factor, there are other sides to this question which should be considered. I wish to say just a word on the humanitarian and esthetic side.

One who has followed the reports of boiler explosions will have noticed that the vast majority are in small plants while very few occur in large central stations. Every boiler installed in the basement of a large building is a menace to the lives of hundreds of people, and while a rigid system of boiler inspection can greatly reduce the danger, the only way to remove it is to remove the boilers.

There is an ever growing movement in all our large cities against the smoke evil, and this movement will not stop till it has accomplished its purpose. It is well known that next to the railroads the small plants are the worst offenders, while large stations are comparatively free from smoke.

An ideal city would be one in which all light, heat and power would be produced in one or two large stations. One plan that has been suggested is to have all light and power transmitted electrically, the same station furnishing steam heat for the business portion, while for domestic heating and cooking producer gas could be distributed from one or two plants.

If the power came from a hydroelectric plant, there would be an entire absence of smoke and no need for carting coal and ashes through the streets; a clean city would be the result. This may seem visionary, but there are no engineering difficulties in the way; it is entirely a question of cost.

It is my firm conviction that the time will come when, due to the increasing cost of coal and the advancements made in the electrical industry, that even this difficulty will be removed. While my vision may never be fully realized, I believe that it will in a large measure. Therefore, I want to enter a protest against making mere money the chief consideration without taking into consideration other things.

W. RUSSELL COOPER.

Indianapolis, Ind.

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POWER

Profit as an Item of Power Cost

Among the other items which the central-station men insist that the owner who is considering the use of their service should include in making up the cost of his homemade current is profit.

In the price of the proffered central-station current the profit on the investment is an item; hence, they argue, it is only fair that the plant owner should charge himself with a profit too in making up a cost sheet for comparison with theirs.

The power user is not interested in scientific bookkeeping nor advanced methods of accounting. What he wants to know is whether he will have spent more money for power at the end of a term of years if he puts in or continues to run his own plant, or if he buys electricity from the central station.

The simple and obvious way to do this is to add all of the costs of which he would be relieved if he subscribed to the central-station current and see how the sum compares with what he would have to pay the central station. If the cost of the relief amounts to more than the relief comes to, he cannot make it an attractive proposition by adding enough to his own cost to make up the difference and calling it "profit."

If a man had two hundred thousand dollars to put into a factory, the steam plant of which would cost twenty thousand dollars, and if he expected to make thirty-five or fifty per cent. on his investment in the factory proper, the question might arise whether he might not better put all of the money into manufacturing and make the larger percentage of the whole of it than to take out twenty thousand dollars for a steam plant which would make a profit of only, say, twenty per cent. over what he could buy power for. But if he did this there would always exist the possibility of putting twenty thousand dollars more into the plant and getting a profit of twenty per cent. upon it, which is a good deal more than money costs to loan; so that this argument applies only to a man who is at the end of his credit and whose business is still capable of extension. And for him there stand ready a number of builders of steam plants who are willing to put in a plant, run it for a term of years for what the central-station charges would amount to and then turn it over to him free and clear, making their payment out of the difference between the cost of actually running the plant and the revenue which would otherwise have gone to the electric company. If the above argument were carried out to its logical conclusion, no electric company would own its own station for it would hire a building at a rent that would pay the real-estate man ten per cent.

The American Gas Engine

It is to be hoped that every American builder of gas engines will read the full text of the Pittsburg proceedings of the Gas Power Section, American Society of Mechanical Engineers, of which only an abstract is printed in this issue. The candid recitals of experiences with large gas engines are not only interesting and consoling to those of us whose instinctive faith in the gas engine has hung on in spite of the antics of both its advocates and their opponents; they constitute evidence of the sort which ought to give the gas-power industry a strong impetus in the right direction and renewed vigor to follow up that impetus. Some years ago, in a spirit of absolute friendliness, we suggested to gas-engine builders the expediency of admitting and correcting demonstrated weaknesses and thoroughly investigating causes of trouble, instead of arbitrarily assuming that the gas engine had no defects and the user was always at fault. The experiences related at Pittsburg amply confirm our contention that the practice of gas-engine design was then far from being perfected, and the results that have been achieved through the progressive policy of the large builders in making good their early mistakes (not by any means inspired by our utterances), prove the soundness of our advice—which, incidentally, brought down upon us all sorts of criticism, anathema and even insinuations of ulterior motives, from gas-power advocates who were too short-sighted or petty to realize the justification and sincerity of our attitude.

However, that is another story. The main point in sight just now is that the American gas engine has practically reached the stage of reliability which characterizes the high-grade steam engine, but it still costs too much money and occupies too much space. Get these factors down to where they belong, with-

out relinquishing any of the dearly bought continuity of service, and then "watch it grow."

Prevention of Power Plant Accidents

At a recent meeting of the American Institute of Boiler Inspectors, one of the speakers said that the members were active workers in a movement toward the prevention of industrial accidents. If the intelligent, well equipped inspector who has the courage of his convictions and is unwilling to take a gambler's chance that a "shaky" boiler will not fail before the date set for the next inspection, always insists that no responsibility for an unwarranted certificate shall be laid at his door, this is eminently true. Coöperating with him is the intelligent and conscientious engineer who at every opportunity gives his boilers the same careful examination that is given by the inspector and also uses his influence to discourage the use of boilers of inferior construction.

Until all of the States have taken the same advanced ground regarding steam-boiler construction that Massachusetts and Ohio have, there will be conscienceless boilermakers who will unload the poorest possible boilers on ignorant and penny-wise purchasers. In a great many cases the engineer is not consulted in the matter of purchasing power-plant equipment, and in cases when he is consulted his opinion carries little weight against the specious argument of the trained talker whose sole aim is to give as little real boiler as possible for the price he gets.

Though restricted in opportunities for preventing the purchase and installation of inferior boilers, the engineer can, by the faithful, intelligent discharge of his duty in the handling of such boilers, do much toward the prevention of explosions and become an honored member of a nation-wide society for the prevention of industrial accidents.

The Cornell Economizer

Several of our readers who have successfully used the Cornell economizer or who have known of instances where its use has resulted in increased capacity or improved efficiency, have asked upon what grounds we condemn it.

We do not and have not condemned it. Our previous articles were not directed against the Cornell economizer; we merely questioned the accuracy of a test that was reported to have been conducted on boilers equipped with the device.

There is no doubt that steam can be decomposed by heat; there is no reason to doubt that the temperature of decomposition can be attained in retorts such as are used in the Cornell device. This point was not questioned in our editorial. The steam in its passage from one retort to another in the series has its temperature progressively raised and if enough such retorts are provided, there is no reason why the temperature of decomposition should not be reached.

Necessarily in doing so the steam abstracts heat units from the furnace, and when the resultant mixture is injected into the furnace and burned back to water vapor just as many heat units are released as were absorbed in the process of decomposition. It is in effect a borrowing operation in which the decomposed gases, like an honest debtor, pay back the heat units that were required to insure its creation.

The advantages do not consist of a gain in heat units in this particular part of the performance but are due to the injection of the highly heated supply of oxygen and hydrogen, entraining with it and heating an abundant supply of air, increasing the difference between the ashpit and the furnace pressures and supplying the requisites of combustion while maintaining the furnace above the temperature of ignition, getting in the air necessary to burn the coal without reducing the furnace temperature, which ought to result in rapid and effective combustion, and explains improvements which have been made in boiler efficiency and capacity. It is agreed to install the system under a guarantee to effect a given saving and to remove the device without cost to the customer if it fails to do so. This is an eminently fair proposition and there are doubtless many boiler plants that can be improved as much as is claimed by the Cornell Economizer Company and by the methods which it employs.

Cost of Furnace Upkeep

In forming a mental estimate of the cost of steam making, one is apt to confine his attention too closely to the fuel item and to overlook the cost of upkeep. With the increasing demands which are put upon boilers and the high rates of combustion employed, furnace repairs and renewals come with increased frequency. The cost of such repairs is by no means confined to the expenditures for material and labor in rebuilding the furnaces. There is the loss of the use of the boiler during the time that it is laid off and the fuss and interruption incidental to the presence of workmen and material in the plant. Obviously, a great deal of advantage results from putting in a furnace which will endure, and we suggest as a fruitful subject for discussion by our correspondents the best methods of furnace construction, especially of those using arches; the best methods of laying firebrick and the best sort of material to use. The practice has arisen of brooming the lining of the furnace over after it is in place with a thin wash of fire clay or some refractory material. One engineer has used the finely ground refuse of the carborundum furnace for this purpose. Do any of our readers know anything about the process and its results? Inasmuch as a large part of the expense of such renewals is in labor, interruption to service, etc., it would seem to be good engineering to use high-grade material which costs no more, perhaps less on account of its greater regularity, to lay than the cheaper. In comparing the costs of cheap and high-grade material the cost laid should be that which is considered, and it will usually be found that the difference in cost between the lowest-priced brick which can be found and that of high-class more expensive material when that price is reduced to the cost in the setting will be insignificant when compared with the longer life and more satisfactory service which can reasonably be expected from the better grade.

Information in regard to the method of failure, frequency and cost of renewals, etc., would be appreciated.

The Dignity of Labor

Labor has been variously defined as exertion of body or mind, as implying painful or strenuous effort, as an attempt to attain useful results. Dignity is the state of being worthy, having elevation of mind, superiority and sober judgment.

It is readily seen from the foregoing definitions that there may be much that is without dignity in the labor of some of us, and that occasionally our arrogation of dignity is far from earning its right to be conjoined to labor.

Labor has dignity only when the workman has by skill and common sense so exerted his mind and his body that he proves his superiority to the drudge.

In the engineer who has by his skill shown economical and efficient results in the operation of his plant, the dignity of labor is well exemplified. He is looked up to and consulted by his owners and managers; his ideals are high and he will not stoop to meanness; he is not overbearing and belligerent; he despises the petty grafter; is quick to adopt suggestions that will be beneficial to the managers and add to his own usefulness. This engineer is quick to meet an emergency; he is not a machine that starts and stops automatically. He is quick to see the necessity of keeping a keen eye on his assistants and is ever ready with cheerful advice.

There is good reason for doubting whether the dignity of labor is at all times sustained by engineers who by well directed efforts could easily win for themselves this much to be desired quality.

No industry has become great without the aid of the skilled mechanic—this man of dignity and labor—and his high development in this country has built up its commercial supremacy.

Inquiries of General Interest

Questions are not answered unless accompanied by the name and address of the inquirer. This page is for you when stuck—use it

Changing the Frequency of a Motor

How can an eight-pole 120-cycle motor be rewound for 60 cycles? The rotor is a squirrel cage and there are eight field coils per phase.

C. W. A.

Rewind the stator with four coils per phase, to change it to four poles, putting in twice as many turns per coil as each of the present coils contains. The rotor need not be changed.

Making Ice with Compressed Air

Can you give me some information regarding the method of making ice with compressed air? I understand that the Government is doing it on some of the war vessels. In the plant of which I have charge there is a large air compressor, air cylinders 20x12x22 inches. Having air to spare, we would like to make our own ice for the shops, say one ton per day. The compressor runs in the daytime only. What floor space would a 1-ton machine occupy, and what would a 1-ton machine cost?

A. S.

Dense-air refrigerating machines are used on warships to avoid the danger of suffocation by leaks from the system. These machines are very inefficient in operation and require 10 to 15 times the horsepower used by an ammonia-compression system. If your company wants to manufacture about one ton of ice per day, it would be advisable to purchase a small ammonia-compression system plant with an ice-making tank suitable for this capacity, instead of using the air compressor which is now on the premises. The information about the price and space occupied by such a plant can easily be obtained from the manufacturers of this class of machinery.

Circular and Square Inches

I have a circle 12 inches in diameter and I wish to find the circular inches. How shall I do it?

O. K.

To find the area of a circle the square of the diameter is multiplied by 0.7854.

In comparing the carrying capacity of wires the electricians have adopted the practice of expressing the cross-section in circular mils, which are obtained by squaring the diameter without multiplying by the 0.7854. The circular inches in a circle 12 inches in diameter are in this sense

$$12 \times 12 = 144 \textit{ circular inches}$$

The *actual* area of a circle one inch in diameter is 0.7854 of a square inch.

The number of *circular* inches in it is 1.

The area of one *circular* inch, therefore, is 0.7854 of a *square* inch.

In a circle 12 inches in diameter there are

$$12 \times 12 \times 0.7854 = 113.1 \textit{ square inches}$$

and since in one circular inch there is 0.7854 square inch, in 113.1 square inches there are

$$\frac{113.1}{0.7854} = 144 \textit{ circular inches}$$

In reducing the area in square inches to circular inches 113.1 was divided by the 0.7854 by which the square of the diameter was multiplied to get the area in square inches; that is, the multiplication is undone. The area of a circle in circular inches is simply the square of the diameter, and the object of its use is to avoid multiplication by 0.7854.

Boiling Water at 32 Degrees

Can water be boiled at 32 degrees Fahrenheit? If so, how?

B. W. D.

Water will boil at 32 degrees in a vacuum. If water at 32 degrees is placed in the bell of an air pump and the air is exhausted, the water will begin to boil, and if the vapor is pumped away as fast as formed, the water will all boil away in time.

Operating a Dynamo as a Motor

What proportion of its rated armature current should a direct-current dynamo be able to carry when operated as a motor?

If the magnetic field is slightly weakened by inserting resistance in the field circuit in order to increase the speed, will that cause the armature to run hotter than otherwise?

C. F. J.

Practically the full rated dynamo current. Running as a motor, the speed will be somewhat lower than when driven as a dynamo and this will increase the temperature rise for any given load, but the difference will be unimportant unless the machine was right up to the heat limit when operating as a dynamo.

No.

Length of Steam Ports

What determines the length of the steam ports of a cylinder?

L. S. P.

Steam ports are made as long as the diameter of the cylinder will allow.

Motor Losses and Output

A shunt-wound motor at 500 volts takes 0.9 of an ampere running free. The resistance of the field winding is 1250 ohms and that of the armature circuit is 4 ohms. If a load be applied which makes the total motor current 12.4 amperes, what will be the load and what will be the efficiency of the motor?

C. H.

The field current is $500 \div 1250 = 0.4$ of an ampere, so that the armature current, running free, is 0.5 of an ampere. The resistance drop in the armature is 0.5 ampere $\times$ 4 ohms $=$ 2 volts, leaving the remaining 498 volts to be balanced by the counter e.m.f. The friction and iron losses, therefore, are 498 volts $\times$ 0.5 ampere $=$ 249 watts. These losses may be assumed to be constant at all loads, although that is not strictly true. At a load of 12.4 amperes, 12 amperes will flow in the armature, because the field circuit takes 0.4 of an ampere, no matter what the load may be. The drop in the armature will be 12 amperes $\times$ 4 ohms $=$ 48 volts, so that the counter e.m.f. will be 452 volts. This, multiplied by the current, gives the electrical power expended on outside work and the constant friction and iron losses; the latter are 249 watts, so that the external work must be

$$452 \times 12 - 249 = 5175$$

watts, or $5175 \div 746 = 6.94$, or practically 7 horsepower. The efficiency is the net work divided by the total power intake. The latter is $12.4 \times 500 = 6200$ watts and the former 5175 watts; the efficiency, therefore, is

$$\frac{5175}{6200} = 0.83467$$

or practically 83½ per cent.

Heating and Ventilation

Considered as power plant problems. Layout and operation of systems and apparatus

Coefficients of Heat Transmission *

By Prof. R. Allen

Heat is lost and conducted from or to a body in three ways, by radiation, by conduction and by convection. In most of the problems in connection with engineering work heat is transmitted by radiation and convection from a surface; the loss of heat by radiation for ordinary differences in temperature depends upon the difference in temperature of the two bodies between which there is a transfer of heat and upon the nature and condition of the surfaces composing these bodies. The loss by convection depends upon the difference in temperature between the medium passing by the surfaces and the temperature of the surfaces to and from which the heat is being conducted, also upon the form of the body and the velocity of the air passing the surface. In general it is independent of the nature of the surface.

In heating work it is very important to know the heat loss through the various forms of heating surfaces. These surfaces may be divided into two general classes: those in which the heat passes from the surface by the natural circulation of the air along the surface produced by the heated surface itself, and those in which the air passes by the surface due to a forced circulation, as in a fan system. In the first class a large portion of the heat is given off by radiation and in the second it is almost all given off by convection. Consider first those surfaces along which the air circulates by natural draft.

Engineers have generally agreed in this case that the transmission of heat depends upon the difference in temperature between the air in the room and the steam in the radiator multiplied by a certain constant depending upon the form and the condition of surface. Experiments upon the transmission of heat through surfaces have been conducted at the University of Michigan for about twenty years, and it has been found that under similar conditions the coefficient of transmission for the same radiators remains constant. The constants are made known in the following manner: The condensation of the steam in the radiator is carefully determined per square foot of surface and this multiplied by the latent heat of the steam at the given pressure gives the heat loss per square foot of surface. Dividing this loss by the difference in the temperature between the steam in the radiator and the temperature of the air in the room gives the coefficient of heat transmission. Table 1 gives the coefficient of heat transmission for various radiators.

TABLE 1. HEAT TRANSMISSION FROM DIRECT RADIATORS*

Type of Radiator	Square Feet	Pounds Condensed per Hour per Square Foot	Coefficient of Transmission
Cast Iron			
1 column	48	0.212	1.82
2 column	48	0.265	1.65
3 column	45.3	0.204	1.45
6 column	36	0.217	1.35
Wrought Iron			
1 column	12	0.446	3.27
2 column	42	0.286	2.00
3 column	48	0.294	1.77
4 column	48	0.202	1.27
1-in. Pipe Coil			
1 pipe high	....	0.41	2.80
4 pipes high	....	0.425	2.48
	Square Feet per Second		
Wall Coil			
Section vertical	5	.....	1.92
Section horizontal	5	.....	2.11
Section vertical	7	.....	1.70
Section horizontal	7	.....	1.92
Section vertical	9	.....	1.77
Section horizontal	9	.....	1.98

*Hight of cast-iron and wrought-iron radiator is 38 inches.

In order to determine how nearly constant this coefficient remains, a series of experiments were made at varying room and steam temperatures. Table 2 gives the results of these experiments. It will be noticed that for ordinary conditions of operation this coefficient remains fairly constant so that it is hardly necessary to take the variation into consideration, except in very accurate work, and then only where the range of temperature is very great does the variation in this coefficient materially affect the heat loss from the radiator.

The transmission of heat through radiators and also the coefficient of transmission will be affected by the temperature of the surfaces to which the radiator emits its heat. In the first experiments

TABLE 2. HEAT TRANSMISSION THROUGH CAST-IRON RADIATOR UNDER VARYING CONDITIONS OF TEMPERATURE

Difference in Temperature	Coefficient of Transmission
80	1.56
100	1.58
120	1.615
140	1.645
150	1.65
160	1.675
170	1.69
180	1.705
190	1.72

that were made at the University of Michigan, the room used had very little outside wall or window surface. Some 15 years later this apparatus was moved into another room containing a large amount of window surface. The effect of this change was very marked. The coefficient of transmission was raised about 7 per cent. This accounts for the fact that in greenhouse heating the rules are entirely different from those used for an ordinary house. Where radiators are exposed so that the direct rays of heat from the radiator strike directly on cold glass surfaces at a low temperature the radiation loss is measurably increased. This is of great assistance to the engineer, for if he figures his radiation too low in a room with large glass surfaces, he is helped by the fact that the radiator gives off more heat and tends to make up for the lack of surface.

The coefficients given in the previous tables are for rooms having an average amount of glass surface.

The transmission of heat through radiators is also affected, to a small degree, by humidity. The effect of humidity is shown in Table 3.

TABLE 3. EFFECT OF HUMIDITY ON THE TRANSMISSION OF HEAT THROUGH CAST-IRON RADIATOR

Percentage of Moisture ture Saturation	Coefficient of Transmission
20	1.79
30	1.77
40	1.73
50	1.72
60	1.69
70	1.66
80	1.63
90	1.61
100	1.59

It may be noticed that as the humidity in the air increases, the heat losses from

*Abstract of paper read before the National District Heating Association, at Pittsburg, June 6-8.

the radiator diminish. This is contrary to what might be expected, but the reason for it is quite evident when carefully considered. Water vapor occupies twice the volume of air under the same pressure, so that when the air in the room is moistened, there is less weight of the medium passing the radiator than when the air is dry, and therefore less heat lost by convection, which lowers the total heat transmission. The effect of the moisture in the air through the most extreme ranges of humidity only changes the coefficient of transmission about 5 per cent.

The painting of radiators may materially affect the transmission of heat. A series of experiments were conducted about two years ago to determine this effect. Two cast-iron rectangles were used; one was painted and the other left unpainted so that the painted radiator was always compared with the same unpainted radiator. The results of these tests were very interesting. The radiators were first tested both unpainted and the condensation in the two was practically alike. One radiator was then painted with two coats of copper bronze and it was found that the heat transmission was reduced 24 per cent. from the original cast iron. Two coats of copper bronze were then placed upon a radiator and the heat transmission was reduced 25 per cent. Two coats of terra-cotta enamel were then placed over the four previous coats and the heat transmission was 3 per cent. better than the original cast iron unpainted. This was repeated for 14 coats, the last two coats being aluminum bronze. The transmission then showed a reduction of 27 per cent., and additional tests were conducted with various enamels: japan, lead paint and zinc paint. The results of these tests are shown in Table 4.

In general the table shows that aluminum, copper and metal pigments in the bronzes reduce the heat transmission. This is probably largely due to the composition of the bronze and partly to the vehicle which contains this pigment. Enamel, lead paints and zinc paints almost all show no loss in heat transmission. The experiments show that the effect is largely surface rather than conduction effect, and that the loss of heat from radiators depends largely upon the surface effect and to a very small extent upon the conduction of heat through the metals.

Experiments conducted with radiators of the same shape made of different materials, cast iron, wrought iron and copper, do not show a material difference in the heat transmission when painted with similar coatings. This is because the total heat transmission is determined by the point of greatest resistance to the transmission of heat and this point is at the surface, so that the materials of which the radiator is made (which is always a good conductor) has very little effect. For the same reason the thickness of the metal composing the radiator has very little effect.

In indirect radiators where the air passes over the surface at a high velocity, and this velocity is subject to a wide range depending upon the conditions of operation, it is necessary in determining the coefficient of transmission to take into consideration the velocity of the air passing over the surface as well as the difference in temperature between that of the air outside and the steam inside the radiator. The experimental results go to show that this coefficient is almost constant and may be determined in the following manner. Divide the B.t.u. transmitted per hour by the difference between the average temperature of the air passing the radiator and the steam in the radiator. Divide this quotient by the number of cubic feet of air passing per square foot surface per hour. The final quotient will be the coefficient. Table 5 gives this coefficient for an indirect pin radiator of standard form and for a long pin indirect radiator. The irregular variations in the coefficient are undoubtedly due to the errors in observation. It may be noticed that the coefficient increases as the velocity of the air passing the radiator is increased.

Similar coefficients of transmission may be obtained for fan-coil radiation. This is determined in exactly the same way as

TABLE 4. EFFECT OF PAINTING RADIATORS

No. of Test	Average Room Temperature	Average Temp. of Steam Entering Rad.	Condensation per Hr. per Sq.Ft. Actual Surface	B.t.u. Rad. per Hr. per Sq.Ft. of Surface per Deg. Diff. of Temp.	Efficiency	Remarks	
1	74.4	222	0.413	2.82	0.997	Plain as received from factory	
2	76.0	220	0.418	2.94	1.005	Plain as received from factory	These paints, of two coats each, were put on over one another in the order given.
3	63.1	224	0.353	2.16	0.761	Painted with copper bronze	
4	72.3	220	0.325	2.08	0.752	copper bronze	
5	74.5	220	0.436	2.86	1.038	terra-cotta enamel	
6	66.3	218	0.351	2.24	0.735	copper bronze	
7	74.1	224	0.421	2.67	0.977	light-brown varnish	
8	72.9	226	0.431	2.67	0.977	oak-brown varnish	
9	71.8	225	0.318	1.97	0.730	aluminum bronze	
10	70.5	224	0.324	2.005	0.724	aluminum bronze	This series follows one another.
11	66.7	223	0.442	2.68	0.970	silver-gray enamel	
12	67.6	224	0.452	2.75	1.01	snow-white enamel	
13	64.2	224	0.446	2.66	0.997	bronze-green enamel	
14	64.0	224	0.429	2.545	0.956	no-luster green enamel	
15	70.6	224	0.423	2.62	0.997	maroon-gloss japan	
16	68.5	224	0.364	2.22	0.850	shellac and copper-bronze powder	
17	67.0	224	0.347	2.02	0.760	copper-bronze powder and linseed oil	
18	86.9	224	0.379	2.62	0.987	white paint	Painted over one another.
19	83.4	224	0.389	2.65	1.00	terra-cotta paint	
20	86.8	224	0.374	2.59	0.989	light-green paint	
21	77.2	224	0.423	2.72	1.00	light-green paint zinc	
22	77.7	224	0.408	2.66	0.964	terra-cotta paint zinc	
23	76.0	224	0.418	2.70	1.01	white paint zinc	
						Radiator No. 2 plain in all tests.	

TABLE 5. COEFFICIENT OF TRANSMISSION FOR INDIRECT PIN RADIATION

Cubic Feet of Air per Hour per Square Foot Surface	B.t.u. per Hour per Square Foot Actual Surface per Degree Difference Over Air and Steam		Coefficient	
	Short Pin	Long Pin	Short Pin	Long Pin
50	0.80	1.00	1.60	2.00
100	1.52	1.55	1.52	1.55
150	2.25	2.20	1.49	1.50
200	2.85	2.75	1.43	1.45
250	3.55	3.25	1.42	1.30
300	4.25	3.70	1.415	1.23
350	4.85	4.20	1.385	1.20

TABLE 6. COEFFICIENT OF TRANSMISSION FOR FAN HEATER COILS (OUTSIDE TEMP., 0 DEG.)

No. of Section	Velocity through Heater									
	800		1000		1200		1400		1600	
	Vento	Pipe Coil	Vento	Pipe Coil	Vento	Pipe Coil	Vento	Pipe Coil	Vento	PipeCoil
1	0.120	.....	0.120	.....	0.120	.....	0.120	.....	0.120	.....
2	0.0595	0.0535	0.0592	0.0575	0.059	0.058	0.0585	0.058	0.058	0.0575
3	0.0398	0.0350	0.0399	0.0379	0.040	0.040	0.041	0.041	0.042	0.040
4	0.0301	0.0240	0.030	0.0269	0.030	0.030	0.038	0.030	0.039	0.030
5	0.0240	0.0160	0.0240	0.0203	0.0240	0.028	0.0240	0.030	0.0239	0.029
6	0.0198	0.0140	0.0199	0.0165	0.0199	0.019	0.0199	0.019	0.0198	0.019
7	0.0172	0.011	0.0171	0.0145	0.0170	0.017	0.0171	0.017	0.0171	0.0165
8	0.0149	0.009	0.0151	0.0125	0.0150	0.0155	0.150	0.016	0.0150	0.0155

above with the exception that the final divisor is the velocity of air passing the radiator in lineal feet per minute. Table 6 gives the coefficient of heat transmission for 1-inch pipe fan coils. It may be noticed from this table that the coefficient varies with the depth of the fan-coil surface. For any given number of sections the coefficient remains approximately constant.

The object of obtaining these coefficients is to enable the engineer to compute approximately the heat losses in the given forms of surfaces under all conditions. These heat losses have been fairly well determined by experiment for ordinary conditions of operation, but the engineer frequently meets with conditions of operation which are exceptional, and by means of this coefficient he will be able to ascertain the heat losses at least approximately under these exceptional conditions.

At the present time the university is carrying on an elaborate series of experiments with fan heaters and with heating by hot water, and hopes that some more definite information may be obtained with reference to the effect of the velocity upon the heat transmission through metal surfaces.

LETTERS

Radiators Give Trouble

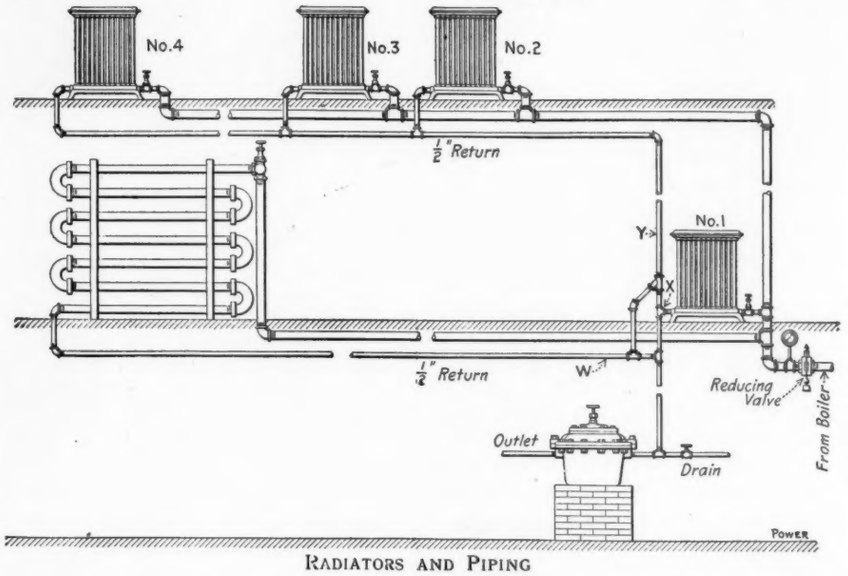
The layout submitted by B. E. Thomas, of Seattle, in the June 13 number, in which he requests readers to solve the trouble he is having in draining his heating system properly, has attracted my attention.

The 1-inch line from the boiler feeds radiator No. 1 on the first floor and Nos. 2, 3 and 4 on the second floor, in the order named. The radiators drain in the following order: Nos. 4, 3, 2 and 1 and thence to the trap, using a single ½-inch line to drain all four radiators. Radiator No. 1 on the first floor, being nearest the boiler, receives the steam at a trifle higher pressure and temperature than do Nos. 2, 3 and 4. Using the tee connection as Mr. Thomas shows at the point *X* to drain radiator No. 1 directs the comparatively hot steam upward as well as downward; the result is a back pressure in the return line *Y* which the condensation of radiators Nos. 2, 3 and 4 is unable to overcome, and thus the return line *Y* gradually fills up and in due time the condensation backs up into radiators Nos. 2, 3 and 4 on the second floor. A check valve placed in the return line *Y* will not overcome the trouble as the pressure from radiator No. 1 is too great to allow the valve to perform its duty as a check valve. Therefore if Mr. Thomas would place a 90-degree ell at point *X*, discard the tee which the present layout shows, cut out about 6 or 8 inches of pipe just above the tee *X* and lead down to the return line *W* with two 45-degree ells, two nipples (one short, the other to suit his requirements), and tie into the return *W* with a Y or lateral, I think he would thus overcome the back pressure from radiator No. 1 and find that radiators Nos. 2, 3 and 4 and the return *Y* would remain free from accumulated condensation at all times.

FREDERICK R. BANKS.

Paterson, N. J.

Chief among the reasons that the three radiators on the second floor fill up with water are the connections into the return line from the radiators on the second floor and from the radiator and pipe coil on the first floor, thus introducing to the return line at such points of connection pressure sufficiently great to prevent the passage of condensation from the second-floor radiators.



RADIATORS AND PIPING

The diagram exhibits other features conducive to imperfect drainage of the apparatus and the surest remedy for the trouble is to disconnect the radiator and the pipe coil on the first floor from the return line and conduct these two drips to a separate trap.

A. S. MAPPETT.

Philadelphia, Penn.

[Another letter along the same lines as the above was received from Fred Wagner, engineer of the Goodrich School, Chicago, Ill.—EDITOR.]

A much more satisfactory answer could be given if the sizes of radiators, main, wall coils, steam trap, etc., had been stated, also the pressure on the radiator side of the reducing valve. If Mr. Thomas is correct in stating that opening the trap drain operates the system successfully, it would appear that the only thing preventing the system from working is a nonworking steam trap. If the trap outlet is clear and the trap in working order, it should carry away the water as easily as the drain, assuming that the trap is large enough to allow all the water of condensation to pass through it. An air cock should be shown on each radiator, and to my mind the ½-inch drip or return is much too small for four radiators and a wall coil, even if all the heaters were very small. Some provision should be made to drain the 80 feet of 1-inch main at the supply end. The connections are not put in according to the best practice, but Mr. Thomas does not ask whether the connections are right or wrong; he only wants to know how to get the radiators to heat and keep them free from water. He practically answers his own question when he states that an open drain will do the trick; all he has to do is to make sure that the trap outlet is large enough and that the trap works properly.

JAMES E. NOBLE.

Toronto, Can.

From the sketch I should say that the return main from the radiators pitches the wrong way and forms a pocket in which the water collects and stops the circulation. No air valves are shown on the radiators, which would also stop the circulation.

JOHN EDWARDS.

Boston, Mass.

Mr. Thomas says that when he opens the drain from the trap, the water passes out and the system works all right again for eight to fifteen hours. This shows that the system is all right and the trouble is between the drain and the end of the outlet pipe. Mr. Thomas does not state to what the trap discharges. If the trap discharges to the atmosphere, I would think that the trap or the outlet pipe is too small or partly stopped up. If it discharges to a closed vessel the same difficulty may result or the pressure in the vessel may be greater than that in the system.

WILLIAM SWOPE.

Tiffin, O.

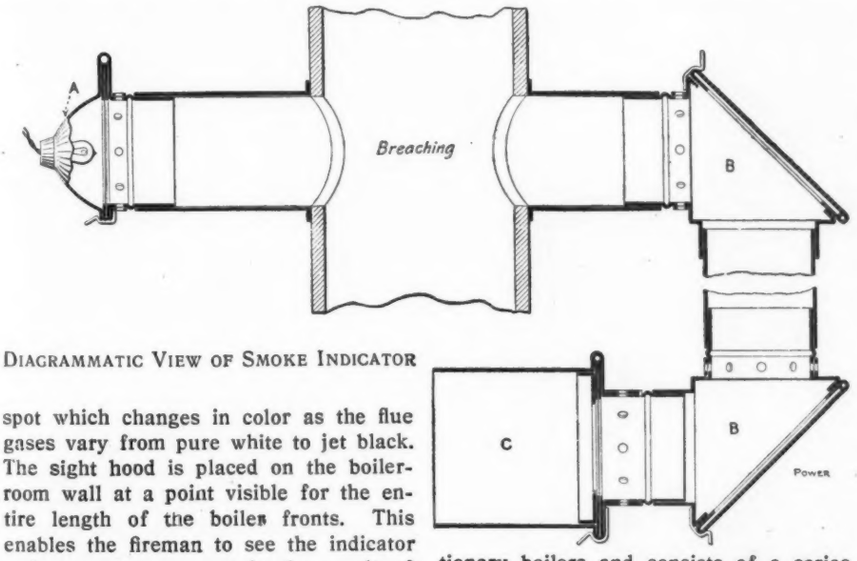
New Power House Equipment

What the inventor and the manufacturer are doing to save time and money in the engine room and power house. Engine room news

B. R. I. Smoke Indicator

The B. R. I. smoke indicator has been designed to indicate when excessive smoke issues from chimneys and to enable the fireman to correct the evil.

The device consists, as shown in the accompanying illustration, of a hinged cone reflector and lamp *A*, attached to the breaching, through which a strong ray of light is reflected through a 6- or 8-inch pipe with suitable 45-degree reflectors *B B*. The light thrown on a ground-glass screen placed in the sight box or hood *C* reveals a large white spot which changes in color as the flue gases vary from pure white to jet black. The sight hood is placed on the boiler-room wall at a point visible for the entire length of the boiler fronts. This enables the fireman to see the indicator and at a glance ascertain the result of any adjustment of air supply, steam jet or furnace arrangement immediately after making it and at the time when he most needs the information.



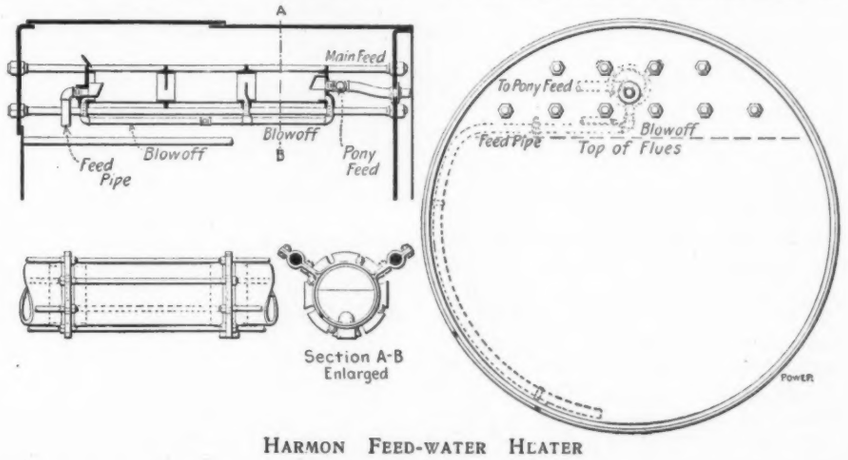
DIAGRAMMATIC VIEW OF SMOKE INDICATOR

As the ground-glass screen is protected by the hood, the device can be used in the daytime as well as at night and offers an unfailing and instantaneous indication of the condition of the flue gases as they pass to the stack. The small holes shown at the elbow connections are for the purpose of admitting air into the pipes, thus preventing eddies of smoke and soot from destroying the brilliancy of the lamp and its reflector. Any number of bends may be made to bring the indicator to the proper position, the light being reflected on hinged mirrors as shown. They can be opened and cleaned when necessary.

The device is being placed upon the market by the Boiler-room Improvement Company, 181 Van Buren street, Chicago, Ill.

Harmon Feed Water Purifier

This device is designed for installation in the steam space of marine and stationary boilers and consists of a series of cast heads, held together by tie bolts, as indicated in the illustration. It has suitable baffle plates to deflect and retard the flow of feed water, that it may be intimately mixed with the steam. The body of the device consists of galvanized sheet casings, which may be easily removed while cleaning. The purifier is attached by hangers to the staybolts and the feed water enters at one end and passes out at the other. Precipitation is caused by the heat of the steam. Blow-off pipes are attached to the different chambers where the sediment collects and the purifier is blown off as frequently as the service requires.



HARMON FEED-WATER HEATER

After passing through the purifier the feed water can be led to any desired point inside the boiler if an increase in the circulation is wanted. It is claimed to be especially valuable in the case of Scotch marine boilers, which are said to have poor circulation at the bottom of the shell. In the illustration the purifier is shown installed in a boiler of this type, with the feed pipe extending down to the bottom of the shell where the hot water establishes circulation.

This device is patented by F. M. Harmon, 1304 Rockefeller building, Cleveland, O. The E. G. Todt Company, 9388 Ewing avenue, South Chicago, are the Western agents.

The William Tod Company is running more than full in the machine shop, but the growing use of large steel castings keeps their foundry output considerably below its capacity. They deal with big things and regard a 1000-horsepower engine as trivial. They have cast bedplates weighing 220,000 pounds each, and have turned out the largest blowing engines in the country with steam cylinders 56 and 108 inches in diameter, air cylinder 110 inches, stroke 60 inches. Each engine has a capacity of 60,000 cubic feet of free air per minute.

A Self Cleaning Boiler

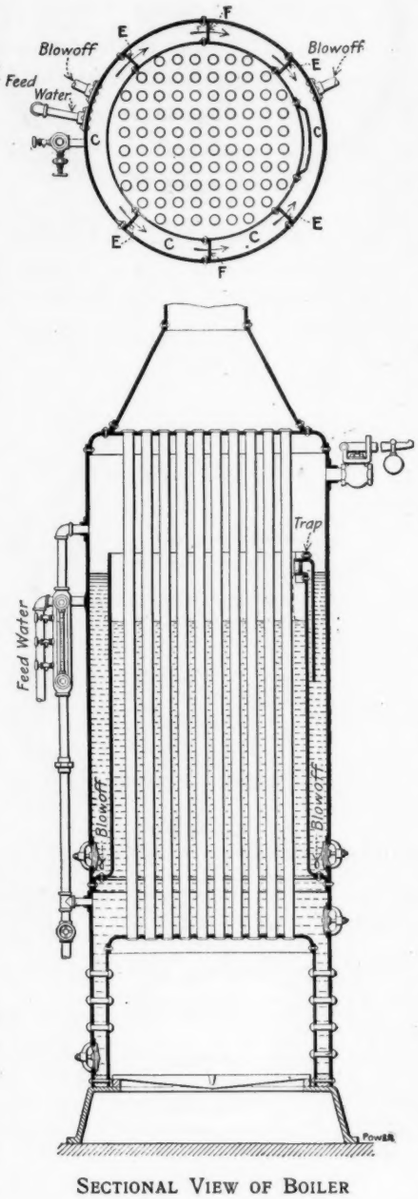
It has been often said that the time to take the scale-making impurities out of boiler-feed water is before it goes into the boiler. From the boiler point of view this cannot be gainsaid, and the advantages enjoyed by a boiler fed by pure water, the evaporation of tons of which would leave nothing behind, would be numerous and important. For the small plant, however, even these advantages have not weighed sufficiently as against the cost of installation and maintenance of a water-purifying apparatus to lead to its general adoption, and the smaller user clings to the practice of making his boiler serve the double purpose of a water purifier and a steam maker, relying upon scale resolvents to keep the deposits from crystallizing upon the surfaces before they can be blown out.

A boiler inspector with a wide experience has conceived an idea of a compromise by putting within a boiler a chamber into which the feed water is introduced and through which it is circulated before being allowed to mingle with the contents of the boiler proper. In so circulating it will attain a temperature at which the scale-making contents will be liberated and be in suspension without using chemicals of any kind. As the movement of the water through the chamber is very slow and as the density of the hot water is low (56 pounds per cubic foot at the temperature corresponding to 100 pounds pressure as against over 62 pounds at 60 degrees), the precipitates settle out easily and may be removed by blowing off. A trap prevents the surface water from passing to the boiler, and an occasional emptying of the tank will remove such floating impurities through the same blowoff.

A boiler embodying this feature and made according to the drawing reproduced herewith was tested at Paterson, N. J., recently. The shell is 42 inches by 9 feet and contains 88 two-inch tubes, each 7 feet long. Riveted to the ring flange is a cylinder of thin plate, 34 inches in diameter and 56 inches in hight, making with the outside shell an annular chamber (*C C C C* in the plan) 4 inches in width and with its top considerably above the top of the gage glass. This chamber is divided by the baffles *E* and *F* (see plan), those designated by *E* having their lower ends 7 inches from the bottom of the tank, so that the water can pass beneath them, and those designated by *F* being in contact with the bottom of the tank, but so short that the water can flow over their tops. The feed enters at the left as shown in both the plan and elevation, through a ¾-inch pipe having an area of about ½ a square inch, and can flow outward from the first chamber through two openings beneath the partitions *E E*, giving an area of

$$4 \times 7 \times 2 = 56 \text{ square inches},$$

or a reduction of velocity in a ratio of 112 to 1. Since the partitions *F* divide the chamber at the bottom, separate blowoffs for the two sides are provided as shown. When the water arrives in the right-hand chamber and attains the level of the overflow, it is discharged as shown, and as the trap draws from about the center of the chamber, floating impurities are retained upon the surface. The capacity of the annular chamber is about 100 gallons or 833 pounds, which would supply the boiler at its normal capacity for nearly an hour.



SECTIONAL VIEW OF BOILER

Remaining in the chamber for this length of time, exposed to the hot water on the inside surface, open to the steam at the top and compelled by the baffles to follow a definite course, the feed water is heated nearly or quite to the temperature of the boiling water before it is admitted to the boiler proper, and as even the sulphates are precipitated at 280 degrees, the water as it goes to the boiler is practically pure. As no flame comes in contact with the chamber in which they are deposited there is no tendency for the deposits to bake on and form scale, and they are easily removed by a periodic use of the blowoff.

The test of the boiler extended over several days and was very severe. The water carried naturally 5 grains per gallon and was loaded with 70 grains of calcium and 70 grains of earth, a total of 145 grains per gallon. The feed was taken from a barrel and was agitated by the introduction of carbonic-acid gas with a view of forming carbonate of calcium. During the test the blowoffs to the separating chamber were plugged, thus retaining the sediment. The bottom blowoff was also plugged. Considerable trouble was experienced with the injector as the feed water was purposely very muddy and far worse than any encountered in ordinary service. After some 1200 gallons of this kind of water had been passed through the boiler it was allowed to cool and the heating surfaces were found to be perfectly clean and the impurities retained in the chamber.

This boiler was designed and patented by T. T. Parker, of Hackensack, N. J.

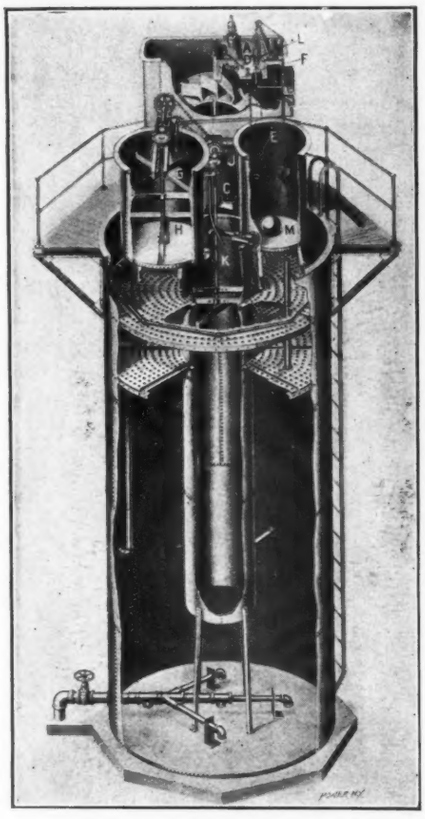
The Bartlett-Graver Water Softener and Purifier

This device is of the automatic continuous type, in that the water is automatically softened in the same quantity as water is withdrawn from the system. The mechanical features of operation and regulation will be apparent from the sectional illustration shown herewith.

The water to be treated flows into a distributing tank *A*, in which it is divided into three streams, the main portion flowing through the opening *B* to the downtake *C*. A second portion flows through the opening *D* into the control tank *E*, and a third portion passes through the opening *F* into the chemical tank *G*. Inasmuch as these three openings are upon the same level they each receive an exact measure of the water entering the tank, the amount depending upon the head of water above the openings.

The chemicals, in the form of suspension, are kept agitated by means of the inclined paddles *H*, motion being obtained from the waterwheel shown, which is operated by the main body of water falling into the softener. Proper amounts of lime and soda ash are placed in the chemical tank and water is added until the level of the solution stands at the edge of the overflow opening *J*. The quantity of chemicals added to the hard water is then governed by the amount of water flowing through the opening into the chemical tank. This water is immediately mixed with the chemicals and displaces an equal volume of solution through the

overflow *J* into the main body of the softener *K*. The water thus added weakens the chemical solution, and in order to continually displace the proper amount of chemicals the quantity of water added must be gradually increased in direct proportion to the dilution of the reagents.



SECTIONAL VIEW OF WATER SOFTENER AND PURIFIER

This increased flow is accomplished by increasing the area of the opening *F* and by raising the tapered plug *L*, the position of which is governed by the float *M* in the control tank. As a fixed proportion of the water entering the system flows into this tank, the level of the water rises in direct proportion to the amount of water which has been treated and raises the tapered plug or cone so as to increase the opening in direct proportion to the amount of water which is being used.

Chemical reaction takes place as the water and reagents descend into the central portion of the purifier, the precipitate collecting as a sludge in the bottom of the main reservoir. Water is drawn from the softener at the top, after it has passed through a filter of excelsior. In some forms of the device a quartz filter is used.

The water softener is built by the William Graver Tank Works, Chicago, Ill.

The price of municipally produced current in Munich is 20 pfennigs (about 5 cents) per kilowatt-hour.

Improved Cookson Heater

If the interior of the heating system is to be kept from fouling, or the condensation from a hotwell or receiver is to be reused, a large oil separator is necessary. The new Cookson cast-iron heater, shown in Fig. 1, has an oil separator big enough to purify all the exhaust steam from all of the boilers or engines of the greatest capacity which the heater can serve. Fig. 2 shows an exterior view of the heater.

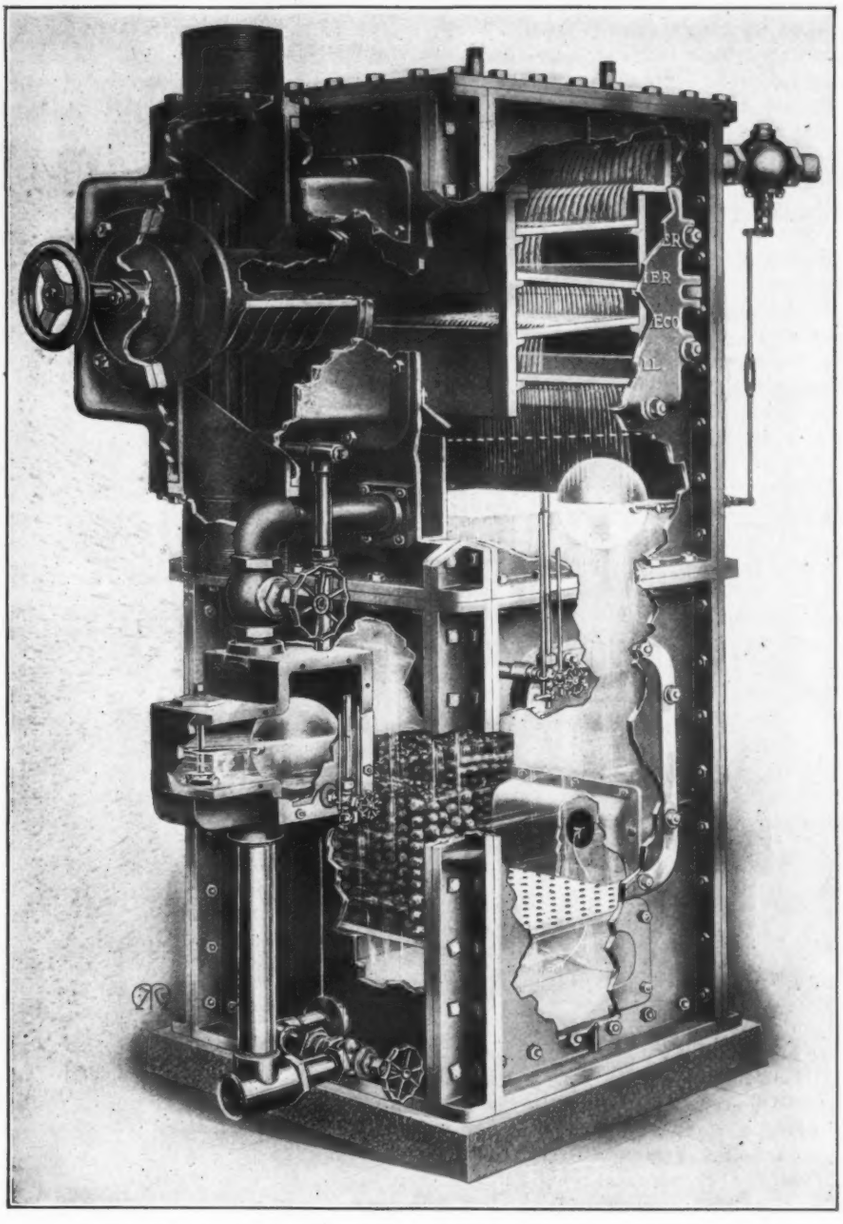


FIG. 1. SEMI-SECTIONAL VIEW OF THE NEW COOKSON HEATER

This heater is made with a cutout valve within the separator, which permits the heater being cut out for cleaning without interfering with the functions of the oil separator. It has exhaust inlet and outlet connections in a direct line to permit the heater to be inserted in a vertical exhaust line without disturbing the pipe except to remove a short length necessary to admit the separator.

This construction greatly reduces complications in piping, valves and fittings and in the labor of installing. In plants where all the exhaust steam comes through one large pipe to a number of heaters the minimum of pipe bends are required to make the heaters deliver into a common stack, and any of the heaters may be cut out for cleaning while the others continue in operation.

Separation of oil and water is accomplished by changing the direction of the current and expansion as follows: Exhaust steam enters the separator from the bottom and leaves through the outlet at the top. As the steam leaves the engine exhaust pipe it passes first through

a tube projecting inwardly on the inlet flange and opens at an angle opposite the opening on the heater inlet tube. The steam is then divided by a V-shaped ribbed baffle cast on the underpart of the heater inlet tube, which deflects the current to the separator walls. The steam currents therefore make nearly a right angle and must travel back again before they reach the exhaust outlet or the inlet tubes to the steam chamber of the heater. Meantime the oil and water particles, due to their greater weight, are dashed against the separator walls, which are ribbed their full length and breadth. Oil and water carried down these ribs fall into a well formed around the exhaust inlet tube, but out of the steam current. This well drains through a balanced float trap (or water seal, if there is no pressure within the heater to require the use of a trap) and empties into the heater overflow pipe. As the oil drain connects to the overflow pipe below the valve in this pipe the separator can drain through the trap when the heater is cut out and the overflow valve shut, thus preventing the entrance of steam from the separator drain into the heater through the overflow pipe.

All steam not going to the heater passes through a tube on the outlet flange similar to that on the inlet flange, but sloping downward and with the angle opening in the opposite direction to that on the inlet, thus compelling the steam to travel in an opposite direction to that in which it entered. This tube also prevents any water or oil that might travel upward on the inside surfaces of the separator casing from mingling with the outgoing steam.

Steam for the heater passes through the central horizontal tube, which is faced on the outer end to form a tight seat for a valve actuated from the outside of the separator. This valve may be opened or closed at will to regulate the inflow to the heater. Steam is drawn into the heating chamber on the vacuum or induction principle by a partial vacuum therein, due to the condensation of the steam. Each impulse of the engine further tends to drive steam into the heater.

The overflow cutout is merely a standard globe valve, and the separator cutout is practically the same. Both are positive and close tight when the heater is cut out. Such valves having flat seats with disks held in place both by positive parts and by the pressure of exhaust steam are not likely to leak, and if they do the seats can easily be reground. The separator valve can be removed through the flanged opening without taking the separator apart or disconnecting any piping.

The cold water comes in near the top of the heater to a spray box which is notched on the edge to spread the water in small streams onto the top tray and successively in a thin layer over the other trays and into the reservoir. A balanced valve in the water line operated by a copper float on the water level regulates the flow of cold water. The trays are readily removed through the upper door when the deposit of impurities renders cleaning advisable. Gases liberated in heating go to the top of the heating chamber, from which a vent permits them to escape to the atmosphere or into the exhaust outlet.

The water is prevented from rising above a desirable level and provision is made for skimming the reservoir surface by an overflow plate that extends horizontally the depth of the heater and drains an even sheet of water into the overflow pipe. The difference between normal and overflow levels is sufficient to take care of any sudden large discharge of water into the heater as from steam traps, or slugs from the heating lines. The trap in the overflow line automatically lets this water out into the waste pipe without letting any air into or steam out of the heater. The removal of any oil or other impurities floating on the water surface is therefore accomplished by merely holding the cold-water valve open until the reservoir level goes above the overflow line.

The filtering material, usually coke, is supported by a removable perforated cast-iron plate which prevents any filtering material from getting into the lower or settling chamber. This lower chamber has at the bottom two flat surfaces sloping to a common gutter at the center. Any minute particles that pass through the filter naturally fall toward this gutter and are removed by opening the blowoff valve.

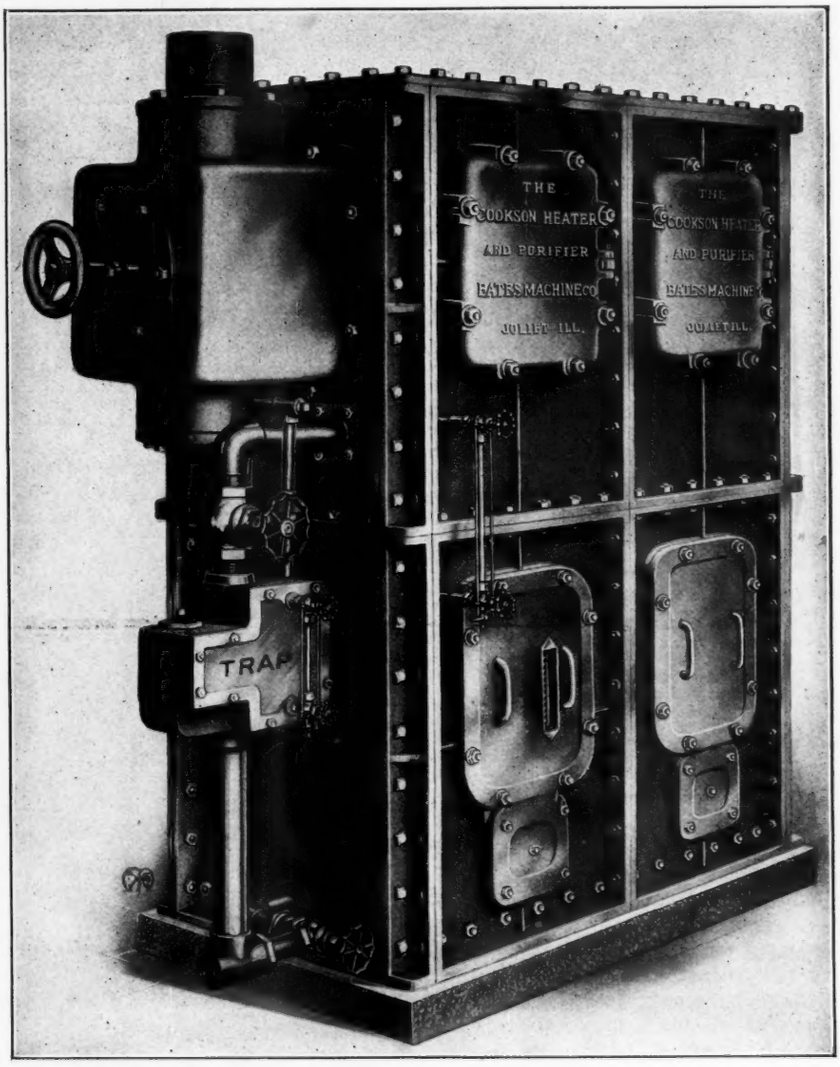


FIG. 2. EXTERIOR VIEW OF THE NEW COOKSON HEATER

Where the heater need not be cleaned while the exhaust steam passes through the separator, the cutout valve is unnecessary and the heater is furnished with the large separator, but without the valve.

If there is no back-pressure valve in the exhaust line, as with engines exhausting entirely to the atmosphere, provision against pressure within the heater is unnecessary and the trap is replaced by a water seal.

The Cookson heater is made by the Bates Machine Company, Joliet, Ill.

California N. A. S. E. State Convention

The eighth annual convention of the California State association of the National Association of Stationary Engineers was held at San Francisco, June 6 to 8, under the auspices of the local associations No. 1 and No. 3. The headquarters was at the Union Square hotel, and the various business meetings were conducted at the Merchants' Exchange building. Of the 44 delegates elected to represent the six associations in the State, 32 were present.

Owing to the labor controversies of the union organizations of the city, which have somewhat affected the local members, there was unusual delay in calling the meeting, notification being issued only 20 days in advance. This necessitated the omission of the customary exhibit feature as well as the preparation of any papers.

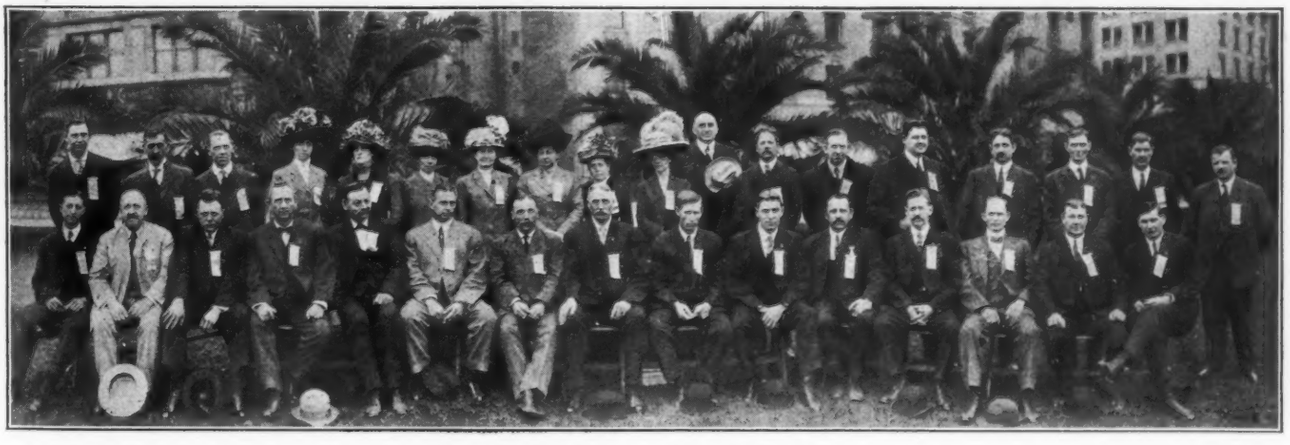
Respecting the labor-union troubles, it was resolved at the opening assembly on June 6 that the association members would remain entirely neutral in any controversy between employers of engineers and the engineers themselves. A committee was appointed, composed of one member from each State association, with John Topham, Los Angeles, as chairman, to draft a State license law, to be presented during the coming year.

In lieu of exhibits an attractive entertainment program was arranged for the visitors, with special sight-seeing trips for the ladies. On Tuesday evening a theater party was held at the Orpheum; on Thursday night an elaborate dinner party was given at the Union Square hotel; on Friday a four-hour trip was taken about the bay in the United States steamer "General Mifflin." Many of the guests remained until Saturday, spending the day in visiting the interesting parts of the city.

The following officers were elected for the ensuing year: President, David Brian, Los Angeles, succeeding H. W. Noethieg; vice-president, L. E. Porter, Santa Barbara; secretary, W. T. W. Curl, Los Angeles; treasurer, Charles Knight, San Francisco; doorkeeper, Philip Ennor. It was voted to hold the next annual convention at Santa Barbara.

Mr. Brian, the State president-elect, has been vice-president of the State association during the past year; he was president of Los Angeles Association No. 2 in 1905. Mr. Curl has been continuously elected secretary of the State association since its inception, eight years ago.

The Los Angeles Association No. 2 is the second largest in the United States, having 444 members, and being only exceeded by Chicago Association No. 1, which has a membership of about 500. The San Francisco Associations No. 1 and No. 3 total collectively 350 members. An effort is to be made during the coming year to establish local orders at San Diego, Oakland and Sacramento.



AT THE CALIFORNIA STATE CONVENTION

Gas and Gasolene Engine Trades Meet at Detroit

With an attendance fully equal to any of the former meetings, the regular semi-annual convention of the National Gas and Gasoline Engine Trades Association was held, June 20 to 23, at Detroit. President C. O. Hamilton presided throughout the sessions, while the city of Detroit was represented at the opening exercises by Lucius P. Wilson, secretary of the Chamber of Commerce.

The program included the following papers, some of which will be abstracted in a later issue: "The Magnitude of the Marine-Engine Business," by H. G. Diefendorf; "The Relation of Ignition to the Sales Department," by R. H. Combs; "Farm Power," by J. E. Waggoner; "The Colleges and Gasoline Engines," by J. B. Davidson; "The Commercial Side of Farm Power," by E. P. Edwards; "Dry-Cell Data for the Engine Manufacturers," by F. L. White; "The Problems Presented to Manufacturers by Users of Magnetos," by R. A. Oglesby; "Gas-Engine Castings," by J. S. Van Cleve; "Advertising the Association," by E. St. Elmo Lewis; "Boosting the Gas-Engine Business," by Albert Stritmatter, and "Aëronautical Motors," by E. W. Roberts.

One of the innovations of the meeting was the dividing of the membership into three sections, under the headings "Engines," O. C. Parker, chairman; "Accessories," M. A. Loeb, chairman, and "Trade Press," E. J. Perkins, chairman, for the discussion of subjects of special interest to the different divisions. This will be continued in the future. The trade-press section introduced a resolution to have a publicity board created for collecting and distributing information of technical interest regarding the association. Action on this was deferred. A steamer ride to the St. Clair Flats as guests of the city of Detroit was one of the most enjoyable social features. During the trip a stop was made at the New Mervue Club, where a six-o'clock dinner was served.

Cleveland was selected as the place of next meeting, the date of which will be in December of the present year.

Connecticut Engineers Hold Convention at Hartford

The sixteenth annual convention of the Connecticut State Association of the National Association of Stationary Engineers was held at Hartford on Friday and Saturday, June 23 and 24, with headquarters at the Garde hotel.

The Putnam Phalanx Armory, conveniently located a short distance from the hotel, was selected for holding the meetings of the delegates and also for the mechanical exhibit under the auspices of the Connecticut State Supplymen's Association.

The large drill room of the armory proved an ideal site for the display of power-plant equipment. The hall was tastefully decorated, and there was abundant light from the windows on either side of the room. Considerable

skill was shown by the committee in the attractive arrangement of the booths. A large space in the center of the hall in front of the platform was plentifully supplied with comfortable seats, and was reserved as a general reception room. The engineering public liberally patronized the exhibit during the two days.

The meetings of the delegates were held in the officers' room, immediately adjoining the exhibit hall.

At twelve o'clock noon on Friday the first session of the delegates was called to order by State President Charles H. Ostrander, who made a short address and appointed the necessary committees.

At eight o'clock on Friday evening the formal opening of the convention took place. The hall was comfortably filled. State President Ostrander in a brief speech introduced Mayor Edward L. Smith, who cordially welcomed the convention to Hartford.

National Vice-President Edward H. Kearney responded for the engineers in a fitting manner. As a close to the ceremonies an entertainment was given by Billy Murray, of Jenkins Brothers; Jim Devins, of the Peerless Rubber Manufacturing Company; Frank Corbett, of the Consolidated Safety Valve Company; Edward Jeffe, and Jack Armour, of POWER. Later on, the supplymen entertained the engineers in the grill room of the Garde hotel, A. R. Foley, Home Rubber Company, and C. F. Heitzmann, Peerless Rubber Manufacturing Company, presiding.

At the meeting of the delegates on Saturday morning the reports of the various committees were read and adopted and other important business was transacted.

It is the prevailing opinion of the committee in charge of the license bill that there is a good chance of its being favorably reported at the next session of the legislature. The bill is now in the hands of the labor committee of the legislature.

The election of State officers for the ensuing year resulted as follows: F. L. Chapman, of Norwich, president; T. J. Phillips, of Hartford, vice-president; N. J. Blacker, of Waterbury, secretary; Thomas Reed, of New Haven, conductor; Henry Heckler, of New Haven, doorkeeper; Frank N. Hastings, of Meriden, State deputy. P. J. Grace, of Bridgeport, George P. Thomas, of Norwich, and Walter B. Holt, of New Haven, were selected as trustees.

The officers were installed by State Deputy J. A. Landon.

The next annual convention will be held at Bridgeport.

At a meeting held by the Connecticut State Supplymen's Association on Saturday morning there was a unanimous reelection of the officers as follows: F. S. Bulkley, Garlock Packing Company, president; R. H. Stiles, Jenkins Brothers, secretary-treasurer; John Foote, McLeod & Henry Company; J. B. Harrington, William R. Winn Company; F. P. Upson, Hartford Mill and Supply Company; executive board.

On Saturday afternoon special trolley cars conveyed the company to Long's Farm, Newington, a pleasant suburb of Hartford, to enjoy a family outing. Upon arrival refreshments were served, after which a baseball match was played between the engineers and supplymen which resulted in a decided victory to the engineers by the score of 9 to 1. After the game dinner was announced and the party repaired to the tables to partake of an appetizing old-fashioned clambake, which brought to a close the most successful convention yet held by the Connecticut State Association.

There were a greater number of exhibitors this year than heretofore, about forty firms occupying booths as follows: American Steam Gauge and Valve Manufacturing Company, Ashton Valve Company, Autogenous Welding Equipment Company, Automatic Steam Trap Company, Baldwin & Stewart Company, Charles A. Claflin & Co., Connecticut Metal Boiler Cleaner Company, M. T. Davidson Company, Dearborn Drug and Chemical Works, Franklin Electric Manufacturing Company, Garlock Packing Company, General Electric Company, Greene, Tweed & Co., A. W. Harris Oil Company, Harrison Safety Boiler Works, Hartford Steam Boiler Inspection and Insurance Company, Home Rubber Company, W. J. Hyland Manufacturing Company, The Iron Works Company, Jenkins Brothers, H. W. Johns-Manville Company, Keystone Lubricating Company, Lake Erie Boiler Compound Company, Long Grate Bar Company, Lunkenheimer Company, McLeod & Henry Company, Mason Regulator Company, C. S. Mersick Company, the *National Engineer, New England Engineer,* George M. Newhall Engineering Company, New York Belting and Packing Company, Nightingale & Childs, Ohio Blower Company, Perfection Grate Company, POWER, *Practical Engineer,* Roto Company, Save Oil Company, Travelers Insurance Company, Universal Lubricator Company, William R. Winn, representing the Quaker City Rubber Company. The Hartford Mill Supply Company had several booths and exhibited for the following firms, Adam Cook's Sons, Jefferson Union Company, Manzel Brothers, Patterson-Allen Engineering Company, William Powell Company, S-C Regulator Company, C. E. Squires Company, R. G. Von Kokeritz Company.

DELEGATES AND VISITORS AT CONNECTICUT STATE CONVENTION

A Correction

In giving the list of exhibitors at the Philadelphia convention of the American Order of Steam Engineers in the issue of June 20, page 980, we inadvertently used one "r" too many in spelling Parkesburg when referring to the firm of Parkesburg Iron Company, located at Parkesburg, Penn.

Incorporation of the Institute of Operating Engineers

On Saturday night, June 17, some 100 members of the Institute of Operating Engineers met in the Engineering Societies building, New York City, for the purpose of taking the necessary preliminary steps to incorporate under the laws of the State of New York.

The meeting was called to order by H. E. Collins. J. C. Jurgensen was made temporary chairman and Mr. Collins secretary.

In his introductory address, Mr. Jurgensen drew attention to the fact that in the United States alone there are some 750,000 men directly engaged in the care and operation of power-generating machinery, representing a capacity of 16,000,000 horsepower and a monetary value of $1,440,000,000. In tracing the development of the institute he stated that the present enrolment includes men in practically every State of the Union and in Canada, Mexico, the Philippines and India.

The present membership is 326. The institute has been progressing in temporary form since March, 1910.

After Mr. Jurgensen had concluded his remarks, two formal resolutions authorizing the legal incorporation of the body were passed. The petition for a charter was signed by the following members of the executive committee: J. C. Jurgensen, H. E. Collins, Willis Lawrence, F. J. Eastment, W. F. P. Hill, J. C. Stewart, F. L. Johnson, W. D. Ennis, J. G. Ould, W. G. Freer and L. Houmiller.

Prof. W. D. Ennis, of the Polytechnic Institute of Brooklyn, stated that after mature consideration he felt that a membership of 3000 could be attained within six months.

A. R. Maujer, who followed Professor Ennis, urged enthusiasm as a valuable asset for the young organization and a general spirit of "boost" on the part of the members.

Wilson Van Buren, editor of *The Engineer's List*, spoke briefly in indorsement of the aims and methods of the institute.

D. B. Heilman, master mechanic of the Philadelphia & Reading Railroad, gave a straightforward, encouraging talk on the prospects of branch organization throughout this country.

Willis Laurence, chief engineer of the Interborough Rapid Transit Company, in his usual happy vein, contrasted the status of the engineer with that of the apartment-house janitor and referred to the work of the institute in standardizing grades of membership as doing for organization what standardized machinery and efficiencies do for equipment.

J. G. Ould, of the Polhemus Clinic, one of the pioneers in operating-engineering education, forecasted a steady increase in the standards of educational requirements.

Timothy Healy predicted a sound financial reward for those who by study and practice improve their qualifications.

F. L. Johnson delivered one of his characteristic "charges to the jury" and asserted that unqualified success seemed assured for the Institute of Operating Engineers.

The annual meeting of the institute has been fixed for Friday, September 1, by which time it is hoped that in membership and financial resources the organization will be in a permanently sound condition. Branches have been started in Manhattan and Brooklyn boroughs of New York City, Chicago, Binghamton, N. Y., Yazoo City, Miss., and Providence, R. I. The membership is increasing at an accelerated rate, 104 members being enrolled since February 1.

Rendering Boiler Accident

A serious accident occurred in the works of the Newburgh Rendering Company, Newburgh, N. Y., on June 20, in which one man was killed.

A large boiler used for rendering purposes and carrying 40 pounds pressure began to leak around a 14-inch manhole cover. This cover was fastened by two lugs and shackles. A bar of iron with a large tee-bolt was used to tighten up the joint. On noticing the leak the engineer tried to tighten up the tee-bolt by placing a piece of pipe over the end, thereby overstraining the parts. One of the shackles gave way, the cover blew off and the contents were strewn all over the engineer, resulting in his death.

It appears that he had done this time and again, although cautioned to the contrary.

Colorado Plants Purchased

H. M. Byllesby & Co. have purchased the Pueblo & Suburban Traction and Lighting Company and allied interests in Colorado, the property being taken over June 14. This company operates the street-railway system of Pueblo and supplies electricity to Pueblo and the Cripple Creek gold-mining district, including the cities of Cripple Creek, Victor and Goldfield. The towns of La Junta and Rockyford are served with electricity by subsidiary corporations.

A steam-electric power station of 4135 kilowatts at Pueblo and a hydraulic power plant of 1600 kilowatts at Skaguay are operated. Arrangements are being made to increase the capacity of the steam station at Pueblo and to extend transmission lines to serve additional cities and towns. Additional hydroelectric developments are also contemplated. W. F. Raber is at present in charge of management for Byllesby & Co.

PERSONAL

B. W. Slocum, who for the past six years has been chief engineer in charge of the plants of the Portland Railway, Light and Power Company, has recently been made manager of the Oregon Dry Dock Company, Portland, Ore.

John J. Calahan has been appointed supervising engineer of schools and chief engineer of the high school at Jersey City, N. J. He will supervise the work of the janitors and janitor-engineers of all schools in that city, including the inspection of construction of the technical and industrial high school.

Frederick K. Blanchard, 422 River street, Troy, N. Y., will represent the Homestead Valve Manufacturing Company, of Pittsburg, in the cities of Albany and Troy, N. Y., and vicinity. Mr. Blanchard will have a stock of Homestead valves on hand at all times and will be prepared to supply the engineers and power plants of those cities on short notice.

A. C. Scott is president of the Scott Engineering Company, Dallas, Tex., which has just been organized and is prepared to supervise either general or special work in the following engineering lines: Electrical, steam, gas, waterworks, irrigation, refrigeration, reinforced concrete, heating and ventilation, Texas fuel properties and tests of oil, coal and lignite. Plans and specifications are also furnished and reports made on power-plant operation and economy.

SOCIETY NOTES

The Combined Associations of Engineers, of Brooklyn, N. Y., held its annual outing on Sunday, June 18. Two special trains conveyed the engineers and their guests to Bellwood park, N. J., a most picturesque and appropriate resort place. Dancing and outdoor sports of all kinds were enjoyed. There was a long program of races, first and second and in many cases third prizes being presented to the winners. A baseball match closed the day's fun. The Engineers' Blue Club played a nine picked from the Combined Associations of Engineers, the latter winning by the score of 11 to 6.

OBITUARY

Charles A. Hague, consulting engineer, died on Sunday, June 25, at his home in New York City. Mr. Hague was one of the founders of the American Society of Mechanical Engineers and a specialist in pumping machinery and waterworks engineering. He has had a long and successful engineering career and leaves behind him many friends in and out of the profession.

Moments with the Ad. Editor

A department for subscribers edited by the advertising service department of Power

(Continued from last week)

Who Has The Say?

By C. A. TUPPER *

[In last week's issue it was shown that today the operating engineer is the man behind the sale—the man whose word is law in the buying of equipment for his plant.]

NOW about the consulting engineer; where does he come in?

The consulting engineer of today, who is "wise in his generation," does not interfere in the purchase of equipment further than to make suggestions for the consideration of the owner and his chief operating men. This applies to machinery of any kind; but more particularly to power apparatus. The consulting engineer concerns himself only with the layout of the plant, and, beyond designating a certain *standard* of equipment necessary to the successful working out of his plans, he does not ordinarily specify the exact makes of the apparatus to be bought.

There are, of course, exceptions to this. For example, a newly incorporated company may be arranging for the erection of a plant. Until ready to begin operations it will not have need of an organization for operating. Consequently, the consulting engineer not only draws the plans but usually supervises construction and takes bids for the equipment. A great deal of machinery is annually purchased on that basis. The consulting engineer is, therefore, not to be ignored. Far be it from me to convey that impression.

But the vast majority of purchases will continue to be made by concerns that do have a capable operating organization; and such purchases are either for increasing the capacity of an established plant or for equipping a new one made necessary by the growth of the business.

When this is true, the consulting engineer who attempts to dictate the buying of the machinery is treading on dangerous ground. He immediately brings into antagonism with him the engineers to whom its operation will be intrusted, and their criticism, well directed, may discredit his entire work. That there are not more is due to the fact that experience is usually an effective teacher.

What about the preference of the owner?

Such preference, if traced to its source, will almost invariably be found in the record of machinery previously used, as interpreted to him by the men in his employ responsible for its efficient operation. This preference is, no doubt, affected very materially in its inception by the reading of the right sort of advertisements, by what is seen at other plants, what is heard at conventions and by his personal liking for the proprietors, manager or salesmen of some machinery-building house. But these are details that simply lead him to talk over the subject with his engineer and have the latter investigate them for him. It is the same when any salesman calls, in the regular course, to present the superior merits of his machine. He is either referred directly to the engineer in charge, or the claims which he makes are noted down, to be taken up with the latter at a convenient time.

Seldom, indeed, does the owner or executive official of any concern make a decision, on his own account, that is contrary to the judgment of the engineer responsible for the successful operation of the power plant.

The matter of price is, of course, a determining element in many cases where standard equipment is to be purchased. That holds true of apparatus for any service. Even here, however, the operating engineer has a voice in the decision. His first preference may give way to a second or a third; but no machinery will be bought, as a rule, that he does not indorse.

Similarly, whatever the man in charge of a power plant condemns has no chance of acceptance, unless it can be shown that he is mistaken. Occasionally such proof becomes necessary.

It is, however, a further demonstration of the influence of the operating engineer that no experienced salesman will uncover any error of judgment, on the part of the former, in the presence of the owner or manager of a plant, without first having a good talk with the engineer opposing him.

Should he find the latter unduly prejudiced, and obstinate in clinging to his error, he has, naturally, no course open but an appeal to higher authority; but he will try every possible means to avoid it.

I was once present at a conference between the proprietor of a factory, his engineer and the expert representative of a machinery house, where the last named acted without tact in exposing a fault in the operating man's experience. The sale was hopelessly lost from that moment, and, to my certain knowledge, no further purchases have since been made from the concern whose agent behaved so indiscreetly.

There are, unfortunately, a great many sales managers who have had no actual selling experience in the field. In the cities where these officials usually have their offices, they come into frequent business intercourse with consulting engineers, meet them at their clubs or on the golf links, and get to think that such engineers practically control the selection of equipment.

A really good salesman, on the other hand, often fails to reach the grade of sales manager because he has no executive ability and would be out of place at a desk. Consequently, the real influence of the operating engineer is frequently unrecognized when it comes to advertising and selling campaigns.

It is remarkable, sometimes, how long such a condition can last. I have in mind, at this moment, some very glaring examples where it has existed for years, with serious detriment to the machinery manufacturers' interests.

The *practical* man in charge of a power-equipment company's sales, however, whether he be the president, vice-president, secretary, general manager or is known as sales manager, has a lively appreciation of the operating man's importance. He advertises directly to him, distributes literature with facts appealing to his needs, cultivates his acquaintance at conventions and has the company's representatives keep in touch with him at every possible opportunity.

To keep continuously before the thousands of operating engineers now employed in this country alone is, however, a task of stupendous proportions. A mailing list, carefully selected and maintained, enables circular matter to be distributed to advantage, but the cheapest and most effective means of reaching them is, of course, through the paper that the engineer regularly reads.

Nor does a card or stereotyped advertisement serve that purpose well.

Announcements in the space that is purchased should be so prepared as to convey a message to the operating engineer, precisely as a good salesman would talk.

The man in charge of a power plant is not particularly interested in the claim that you build the world's best machinery; others have done so and passed along. But, if you can give him facts concerning its construction and operation that appeal to his judgment, *he will be as glad to read them as you are to have him do so.*

The reading columns of a good class journal, while barred to worthless "write-ups," are also open to information of any kind that will really interest its readers; and power-machinery manufacturers who make a practice of supplying it are given a further opportunity of keeping before the operating engineer.

To all such I would say: "Treat of theory only so far as it explains desirable features of design; avoid the commonplace details of construction and bring out clearly just what service the machinery or other apparatus will perform. If operating tests and records are available, give them with sufficient fullness to render them convincing and state just where and how they were secured. Then, when your salesmen go on their rounds, they will find interested listeners among the men in charge of the plants where you hope to place your equipment.

"But, whatever you do, don't make the mistake of ignoring the operating engineer. Leave that to the men who never sold goods, but know all about how it should be done."

*Formerly with Allis-Chalmers Company.

Peat Powder vs. Coal as Fuel

A number of practical tests, undertaken at various places in Sweden, distinctly point to the fact that peat powder can successfully compete against coal as boiler fuel. At the Sahlström factory in Jönköping several thousand tons of peat powder have been used as boiler fuel with the result that one ton made from good peat has been found, if properly utilized, to be equal to one ton of good English coal. Powder made from second-quality peat, naturally, is a less efficient fuel, but still a perfectly serviceable one, which is a point of considerable importance. Experience has also shown that it does not pay to carry the "refining" process too far, and the best remunerative result is obtained by only reducing the percentage of water to 15 per cent. The powder will be cheaper but also slightly less efficient than if the contents of the water were reduced to 12 or even 10 per cent. Mr. Ekelund, who for years has carried on experiments in this direction, sums up the results of his experience in the use of powder obtained from medium peat, with 15 per cent. water, as follows: He thinks 1.2 tons is equal for boiler fuel to 1 ton of the best coal, and for peat powder made from good peat the value is about equal to that of the best coal, ton for ton, under working conditions. Peat powder can be produced at $2.25 per ton, inclusive of interest and sinking fund, while coal delivered to the railway in Swedish ports at present costs $4.12 per ton, and the inland price will average $4.75 per ton. The Swedish Union of Boiler Owners has commenced experimental tests with the new fuel, and the leading Swedish state expert in this matter also speaks very favorably of the Ekelund peat powder, stating unhesitatingly that, in his opinion, peat powder as boiler fuel excludes all competition on the part of coal. Peat powder is also, by way of experiment, being used for electric ore smelting, and very favorable opinions as to its value have also been expressed by a mining engineer.—*Engineering.*

BUSINESS ITEMS

L. L. Wilkinson, of Atlanta, Ga., has recently joined the brass sales department of the Ohio Brass Company, Mansfield, Ohio. Mr. Wilkinson will continue to make Atlanta his home and will travel the southern States in the interests of the Ohio Brass Company's valves and steam specialties.

The New York Edison Company has placed with the Westinghouse Electric and Manufacturing Company, East Pittsburg, Penn., an order for furnishing a 1000-kva. oil-insulated, self-cooling transformer of the tubular type. This is a duplicate of an order placed with the Westinghouse company last year.

The Bigelow Company, New Haven, Conn., has received an order from the New York, New Haven & Hartford Railroad Company for two 500-horsepower Bigelow-Hornsby water-tube boilers for the new round house at Cedar Hill, Conn. In addition to this the Bigelow Company is now building twelve 625-horsepower Bigelow-Hornsby water-tube boilers for the New York, New Haven & Rartford Railroad Company for its new power station at Cos Cob, Conn., and four 500-horsepower Bigelow-Hornsby water-tube boilers for the Connecticut Company, at Housatonic Power Company, Waterbury, Conn.

NEW EQUIPMENT

Talent, Ore., is to install a water system.

Holden, Mass., will extend its water system.

Redmond, Ore., will install waterworks system.

Jesup, Ga., voted $25,000 bond issue for waterworks.

Phœnix, Ore., will vote on installing a pumping plant.

Portsmouth, Ohio, will install a large waterworks plant.

Merrill, Ore., is planning the installation of a waterworks system.

Bennington, Okla., will construct waterworks at a cost of $20,000.

Bridgeport, Conn., contemplates building a municipal electric-light plant.

The Fall River (Mass.) Electric Light Company will enlarge its plant.

Palacios, Tex., voted $18,000 bond issue for the construction of waterworks.

Oakland, Ore., has voted bonds for $15,000 for a new light and power plant.

The Dent Hardware Company, Fullerton, Penn., is building a new power house.

The Valley Water Company, La Canada, Cal., will install a waterworks system.

The York Light and Heat Company, Biddeford, Me., will install new equipment.

The Meriden (Conn.) Industrial Building Company will erect a new power plant.

West Newbury, Mass., contemplates installing a municipal electric-light plant.

Westfield, Mass., has voted $25,000 bonds to enlarge its gas and electric-light plant.

The Neuweiler Brewing Company, Allentown, Penn., is building a new power house.

The Dayton (Ohio) Power and Light Company will construct a new electrical plant.

George Gillett, Richland, Ore., is planning to install a pumping plant on the Snake river.

The Harmony Mills, Cohoes, N. Y., has commenced work on a new electric power plant.

The National Silk Dyeing Company, Allentown, Penn., is making additions to its power plant.

The Jotham Bixby Company, Los Angeles, Cal., will build an addition to its cold-storage plant.

Selma, N. C., contemplates installation of an electric-light plant. John A. Mitchell, mayor.

The Phillips (Me.) Electric Light and Power Company will make improvements at its plant.

The Bakersfield (Cal.) Ice Delivery Company will erect a new cold-storage plant at Taft, Cal.

Mercy Hospital Corporation, Springfield, Mass., will erect a laundry and heating plant to cost $16,000.

Southampton, Ont., will buy a new turbine pump and electrical equipment for extensions to its waterworks system.

New Glasgow, N. S., will spend $200,000 for improvements to its waterworks system, including new pump house.

The Liberty (Tex.) Light and Power Company has commenced the construction of an electric-light and ice plant.

The Brockport-Halley Water Company, Brockport, N. Y., will spend $15,000 in improvements at its two plants.

Power-plant equipment will be required for the new hotel to be erected by the Smith Hotel Company, Portland, Ore.

The W. P. Hammer Company, San Francisco, Cal., is planning the erection of a power plant at Lake Tahoe, Cal.

The Hercules Paving Company, Philadelphia, Penn., is having a boiler house erected at Ring street and Schuylkill river.

The State Normal College, Dillon, Mont., will build a new boiler house and install new equipment. Dr. H. H. Swain is in charge.

The Pacific Light and Power Company, Los Angeles, Cal., is making plans for a new power plant on Big Creek, in Fresno county.

The Riverside (Cal.) Water Company is planning for a bond issue of $750,000 to be used for improvements in waterworks plant.

An electric-light plant will be installed at the State Hospital, Raleigh, N. C. S. O. Middleton, Hallsville, N. C., is on the executive committee.

The Northern California Power Company, Sacramento, Cal., will increase the capacity of its power plant at Kilarc, from 5000 to 8000 horsepower.

Springfield, Mass., is contemplating the installation of a new heating plant, laundry and refrigerating plant in the almshouse and tuberculosis hospital.

The Sierra & San Francisco Power Company, San Francisco, Cal., has issued bonds for $1,000,000 to be used for power-plant construction on the Stanislaus river.

The Sidney Ice and Storage Company, Sidney, Ohio, has been organized with $25,000 capital to manufacture ice by H. E. Bennett, W. B. Taylor, E. W. Bringham, etc.

The Independent Ice Company, South Bend, Ind., has been organized with a capital of $20,000, to manufacture ice. Directors are D. P. Clem, G. D. Staples, W. M. Hildebrand.

The Distilled Water Ice Company, Youngstown, Ohio, has been incorporated to manufacture ice by W. H. Winsworth, H. A. McIntosh, Frank L. Baldwin, etc. Capital, $10,000.

NEW CATALOGS

Schutte & Koerting Company, Philadelphia, Penn. Catalog 3, Section H. Hydrokineters. Illustrated.

The Mechanical Rubber Company, Cleveland, Ohio. Loose-leaf catalog. Packings. Illustrated.

The Roto Company, Hartford, Conn. Catalog. Roto tube cleaners. Illustrated, 26 pages, 6x9 inches.

Crocker-Wheeler Company, Ampere, N. J. Booklet. Remek transformers. Illustrated, 16 pages, 3½x6 inches.

The Bristol Company, Waterbury, Conn. Bulletin No. 131. Recording voltmeters. Illustrated, 42 pages, 8x10 inches.

Terry Steam Turbine Company, Hartford, Conn. Bulletin No. 9. Centrifugal pumps. Illustrated, 8 pages, 6x9 inches.

Greene, Tweed & Co., 109 Duane street, New York. Catalog. Palmetto packing. Illustrated, 24 pages, 5x6½ inches.

C. Lee Cook Manufacturing Company, Louisville, Ky. Catalog. Metallic packing. Illustrated, 20 pages, 3½x6 inches.

The Ohio Brass Company, Mansfield, Ohio. Catalog K. Valves, water gage, gage cock, etc. Illustrated, 56 pages, 6x9 inches.

The Toledo Pipe Threading Machine Company, Toledo, Ohio. Catalog. Pipe-threading tools. Illustrated, 48 pages, 5x7 inches.

Sterling Blower Company, Hartford, Conn. Catalog. Slow speed, low power, steel plate exhausters. Illustrated, 12 pages, 6x9 inches.

The Babcock & Wilcox Company, 85 Liberty street, New York. Catalog. Rust water-tube boiler. Illustrated, 52 pages, 7½x10½ inches.

John Acton, 118 John street, Brooklyn, N. Y. Catalog. Valves, damper regulator, grease extractor, steam trap, etc. Illustrated, 64 pages, 3½x6 inches.

Lippincott Steam Specialty and Supply Company, Newark, N. J. Bulletin No. 26. Indicators for steam and gas engines, ammonia compressors. Illustrated, 8 pages, 7½x9½ inches.

A. L. Ide & Sons, Springfield, Ill. Bulletin No. 17. Simple side crank engine. Illustrated, 12 pages, 8x10½ inches. Bulletin No. 18. Side-crank tandem compound engine. Illustrated, 12 pages, 8x10½ inches.

General Electric Company, Schenectady, N. Y. Bulletin No. 4826. Water-flow meter. Illustrated, 6 pages, 8x10½ inches. Bulletin No. 4827. Air-flow meter. Illustrated, 10 pages, 8x10½ inches. Bulletin No. 4836. Steam-flow meter. Illustrated, 16 pages, 8x10½ inches. Bulletin No. 4835. Electrically driven pumps. Illustrated, 20 pages, 8x10½ inches.

HELP WANTED

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

ENGINEERS to solicit orders for the Rolin patent adjustable grate bar. Apply Standard Grate Co., Heed Bldg., Philadelphia, Penn.

WANTED—Thoroughly competent steam specialty salesman; one that can sell high-grade goods. Address "M. M. Co.," POWER.

AN ENGINEER in each town to sell the best rocking grate for steam boilers. Write Martin Grate Co., 281 Dearborn Street, Chicago.

AGENTS WANTED for first-class steam specialty in use throughout United States. Address C. S. Wood, 410 S. 15th St., Philadelphia, Penn.

WANTED—Salesmen or engineers who can sell grates, to represent the Shear Klean rocking and shearing grates. Address Chicago Grate Company, Monadnock Block, Chicago, Ill.

WANTED—Chief engineer, 2000-horsepower boiler plant, Wickes boilers, Murphy stokers, Hamilton Corliss engines, 50-kilowatt dynamo. Address for particulars, J. S. Eckert, Janesville, Wis.

THE VULCAN SOOT CLEANER offers an exceptional opportunity for power specialty salesmen. For further particulars address G. L. Simonds & Co., 802 Steinway Bldg., Chicago, Ill.

SALESMAN calling at power plants to handle as a side line superior packing for steam, different from the rest and better. Nugget Packing Co., 185 Summer St., Boston, Mass.

ESTIMATOR on steam power plant piping; must be thoroughly conversant with this particular line of work; steady position for right man; state salary desired. Address "Estimator," Box 454, POWER.

WANTED—A reliable draftsman, with experience in designing and erecting high and low pressure steam piping and sprinkler work. American Writing Paper Company, Dept. of M. & H., Holyoke, Mass.

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Advertisements under this head are inserted for 25 cents per line. About six words make a line.

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Advertisements under this head are inserted for 25 cents per line. About six words make a line.

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Do You Use Condensation for Boiler Feed?

Then make sure that all the oil and grease is thoroughly removed before the condensation enters the boiler.

Else sooner or later you'll have considerable trouble and expense due to plates overheating and bagging.

Bagging plates always mean danger of explosion and possible loss of life. At the very least they mean repair expense, boiler deterioration, and coal waste.

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The thorough way of removing oil and grease from condensation is by means of an

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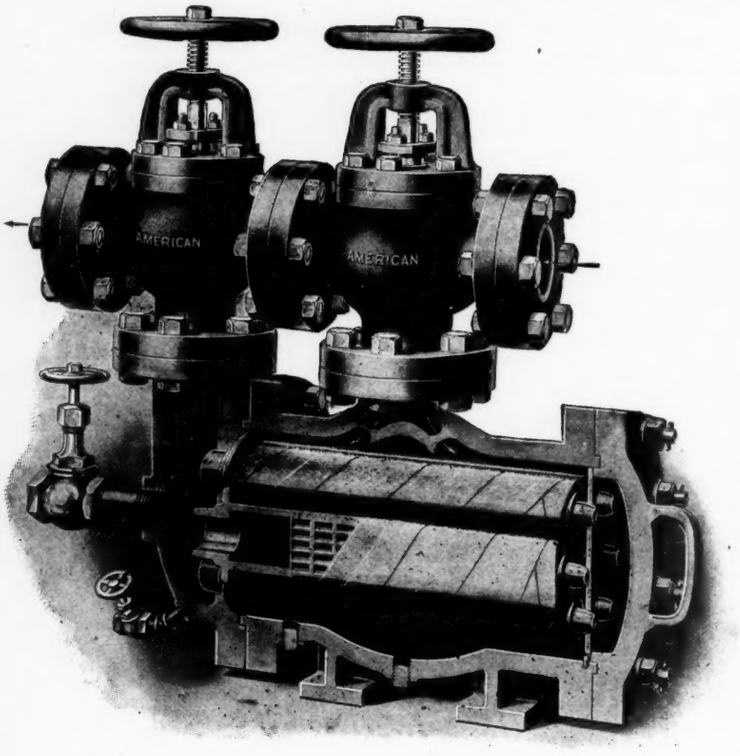

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It takes up little room; all parts are easy to get at; necessary renewals are easily made; its first cost and maintenance cost are low.

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Last week, we called your attention to imitations of our indicators.

We want you to make the following investigations before you buy:

1st—Find out whether the maker is solely a manufacturer of precision instruments, like ourselves, or whether he is just making indicators as a side line.

2nd—Does it stand to reason that the manufacturer of indicators as a side line can produce an instrument of the same quality as ours and sell it for less money? **We know he cannot and, if you figure out for yourself, you'll find it is so.**

Besides, we manufacture a complete line of steam specialties that we want you to use.

3rd—Then does it stand to reason that with our great facilities for manufacturing at the lowest cost, we would charge you one cent more for your indicator, the instrument that will mean the most to you, than any other manufacturer would charge you for an instrument of the necessary accuracy? Again, we say: No, we couldn't afford to.

And that's just the trouble, that **necessary accuracy;** that's what costs and we won't sell you or any one else an instrument that hasn't it.

That's why the American-Thompson brings more than the imitations and that's the only reason.

Wherever you find a manufacturer of high grade precision instruments, the manufacturer of an indicator, this instrument will be high grade also. He can't afford to have it otherwise and he gets as much for it as we do.

This means the manufacturer who sells an instrument under his own name and there are one or two, the more glory to them. They have a reputation to maintain, the same as we have.

Again we ask: can you afford to monkey with the imitations to save possibly ten or fifteen dollars on an instrument that should last a life time? The American-Thompson lasts a life time.

Can you afford to buy any other? Send $5.00 today with proper reference and we'll ship the American-Thompson at once.

American Steam Gauge & Valve Mfg. Company

Boston, Mass.

New York Chicago Atlanta
Pittsburg San Francisco Los Angeles

American Steam Gauge & Valve Mfg. Co.
Boston, Mass.

Send me full details of your Indicator Offer No. 115.

Name . . . . . .

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